554

SCIENTIFIC LIBRARY

UNITED STATES PATENT OFFICE

GOVERNMENT PRINTING OFFICE 11—8625

NOTICE.

All pages missing from this volume are those of ADVERTISEMENTS only, and a specimen of each advertisement published in the volume will be found in the issue of January, April, July and October.

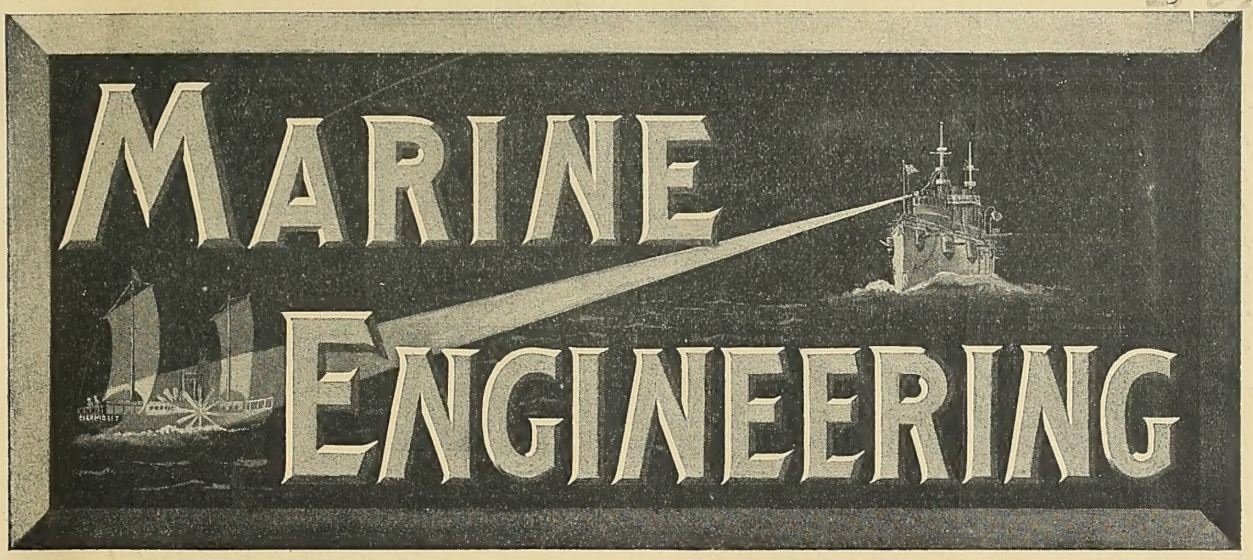
~~and in the selected sheets at the end of the volume.~~

LIBRARY
U. APR 7 1899 S.
PATENT OFFICE.

A. L. Prince

Librarian.

5144 b—500



VOLUME II.

January to December, 1898.

72495

MARINE PUBLISHING COMPANY,

World Building, New York, U. S. A.

ARTICLES.

Accident to transfer steamer Louise,* March, 28.
Admiral Cervera's vessels,* Oct., 16; Nov., 14.
Admiralty law, application of, I. F. Russell, D.C.L., April, 17.
Aluminum for ship construction, J. H. Biles, Jan., 20.
Amendments to U. S. steamboat rules, April, 9.
American Line steamships transferred to Pacific coast, March, 18.
American Society Naval Engineers, annual meeting of, Feb., 26.
Auxiliary vessels for U. S. Navy, May, 13; June, 18; July, 17; Aug. 14; Sept. 14.
Battleship Maine, Court of Inquiry, May, 16; June, 25; Aug., 17; Sept., 24.
description of,* March, 6.
destruction of,* March, 1.
trial trip of, March, 12.
Battleships, new for U. S. Navy,* Oct., 10.
Bazin roller boat,* March, 17.
Boilers, description of water-tube and Scotch,* April, 32.
Brazilian cruisers, Amazonas* and Abrouill, purchased for U. S., April, 1.
Calculations for engineers, Dr. W. F. Durand, Oct., 32; Nov., 39; Dec., 44.
Car ferry steamship, Pere Marquette,* Feb., 1.
Carnegie (Andrew) on the shipbuilding industry, April, 28.
shipyard proposition, reply to, April, 26.
Chilian cruiser O'Higgins,* April, 8.
Coast trade steamer, British,* May, 25.
Compressed air in shipbuilding and shipyard work,* William Burlingham, Sept., 15.
Cornell coaching launch,* July, 13.
Crank shaft for destroyer,* April, 16.
Discipline in British Navy, March, 14.
Dock facilities for U. S. Navy, April, 6.
Docks, floating and graving,* July, 10.
Electrically driven torpedo-boats,* April, 20.
Electricity on board ship, William Baxter, Jr.,* Jan., 28; March, 32; April, 30; June, 37; July, 27; Aug., 26; Sept., 36, Oct., 37; Dec., 47.
Engineers, calculations for, Oct., 32.
Engine breakdown, S. S. Manitou,* Sept., 34.
triple-expansion, modern type,* Sept. 1.
Estimated weights of machinery, Prof. George R. McDermott, Feb., 19; June, 20.
query and reply concerning, June, 37.
Experimental tank at Washington Navy Yard,* March, 18.
Explosions on British warships,* March, 13.
Ohio river steamboat,* Feb., 27.
Ferryboats at St. Louis,* W. H. Bryan, Aug., 1.
Ferry steamers and ice crushers, Straits of Mackinac,* April, 18.
Fire boat Robert A. Van Wyck,* July, 1.
Illinois, for Chicago, Ill.,* Dec. 8.
Fires at sea, destructive, April, 29.
Floating and graving steel dry dock for U. S., Sept., 10.
docks U. S. and foreign,* July, 10.
Foreign ships negotiated for by U. S., April, 5.
Gasoline and gas engines for motor boats,* C. H. Peabody, M.E., June, 6; Aug., 6; Sept., 2.
Gunnery, U. S. at Santiago, Oct., 17.
Hamburg-American new Atlantic flyer, June, 10.
High pressures at sea, W. R. Cummins,* March, 20; April, 22; June, 31; Aug., 16; Oct., 23; Nov., 11.
Hydraulic propelled lifeboat,* Jan., 16.
Ice crushing and ferry steamers at Mackinac,* W. D. Hulbert, April, 18.
Inspection vessel for army engineers,* Sept., 27.
Japanese cruiser Kasagi, Aug., 15.
Lake ships for the Atlantic, Nov., 29.
Launch for coaching at Cornell,* July, 13.
Launch of battleships Kearsarge and Kentucky,* May, 1.
Lengthening river steamer New York,* Jan., 16.
Life boat Queen,* Jan., 16.
trials of, Sept., 21.
London & North Western Ry. Co., officials of,* May, 25.
Loss of S. S. La Bourgogne,* Aug., 24.
Maine, Court of Inquiry,* June, 25; Aug., 17; Sept., 24.
disaster,* March, 1.
Manila, naval battle of,* July, 18.
Marine engine repairs, J. Kyles, M.E., July, 4; Nov., 36.
Mississippi R. R. transfer boat, Oct., 9.
Monitors for U. S. Navy,* Oct., 10.
bids for, Dec., 44.
Motor boats and engines,* C. H. Peabody, M.E., June, 6; Aug., 6; Sept., 2.
Multiple screw towing boats,* June, 12.
aval appropriation bill, May, 7.
fight at Manila,* July, 18.
machinists, etc., regulations for enlistment, May, 8.
shipbuilding programme,* Oct., 10.
volunteer engineer officers, appointment of, May, 8.
Navy, Japanese cruiser for, Aug., 15.
Spanish, strength of, May, 10.
U. S. auxiliary ships for, April, 5; May, 13; June, 18; July, 17; Aug., 14; Sept., 14.
battleships proposed, July, 21.
vessels of, March, 15.
Nickel steel crank shaft,* April, 16.
for ship construction, J. H. Biles, M.I.C.E., Jan., 20.
North German Lloyd Kaiser Friedrich, July, 16.
liners, April, 21.
Oil and coal as fuel on lifeboat Queen,* John Platt, Sept., 21.
President's yacht Sylph,* Oct., 1.
Propeller blades, how to set twin screw,* July, 32.
S. S. St. Paul, phenomenon in,* April, 11; May, 30.
investigation, data on, W. F. Durand, April, 21.
on S. Y. Niagara, Nov., 29.
Quadruple expansion at 500 lbs. pressure,* Dr. R. H. Thurston, Feb., 2.
Repairs to machinery of warships, etc., W. S. Aldrich, Late U.S.N., Dec., 43.
Revenue cutter for the Yukon, May, 12.
Golden Gate,* Jan. 19.
machinery for,* Oct. 12.
service, new ships for, April, 6.
Riveting naval vessels, rules for,* Jan., 12.
Santiago fight, results of,* Oct., 16; Nov., 14.
Sailing ship Blengfell burned, Nov., 39.
Salvage suit, S. S. Haxby, Jan., 33.
work on S. S. Rosedale,* April, 28.
Shaft breakages on Atlantic steamers, April, 28.
Shipbuilding in Bath, Me., Feb., 29.
programme in Congress, April, 6.
returns for U. S. May, 13.
Sketching for marine engineers,* Prof. C. W. MacCord, Feb., 29; May, 33; Nov., 43.
Society Naval Architects & Marine Engineers, proceedings 6th annual meeting, Dec. 22.
Spanish auxiliary cruisers,* July, 8.
battleship Pelayo,* June, 10.
navy, strength of, May, 10.
vessels at Santiago, U. S. report on,* Oct., 16; Nov., 14.
destroyed at Santiago,* Aug., 9.
warship Cristobal Colon, April, 8.
Steamboat City of Savannah burned at Memphis, April, 29.
Grand Republic burned, April, 32.
Gypsy Queen,* Jan., 15.
New York, lengthening of,* Jan., 16.
rules, amendments to U. S., April, 9.
Steamship Arizona reconstructed,* Sept., 28.
Blairmore, loss of, June, 24.
Cambria for L. & N. W. Ry. Co.,* May, 25.
Catalonia, shaft breakage, April, 29.
Clara Nevada, loss of, March, 30.
Columbia,* July, 8.
Cymric, description of,* April, 12.
Dago abandoned at sea, March, 30.
Delaware burned at sea, Aug., 25.
Ems in collision, July, 26.
Greyhound, mishap to engines, Sept., 35.
Inchmona, machinery equipment of,* Feb., 15.
Kaiser Friedrich's maiden trip, July, 16.
Wilhelm der Grosse,* April, 21.
La Champagne, shaft breakage, Apr., 28.
La Bourgogne, loss of,* Aug., 24.
La Grande Duchesse, boilers for, Feb., 16.
Legislator burned at sea, April, 29.
Manitou, smashup of engines,* Sept., 34.
Marie Rickmers, shaft breakage, April, 29.
Mohegan, loss of,* Nov., 38.
Normannia,* July, 8.
Osborne, shaft breakage, April, 29.
Paris, shaft breakage, April, 29; May, 29.
Rosedale, salvage work on,* April, 28.
Statendam, Sept., 2.
Stockholm City, burning of, March, 29.
Tai-Hoku, loss of,* March, 28.
Thomas Cranage, description of,* June, 1.
Tillie, foundered off Barnegat, March, 30.
Veendam, loss of,* March, 27.
Winifred,* Jan., 8; Nov., 1.
Steam yacht for Colonel Oliver H. Payne,* Feb., 12.
Ellide, description and trial trip,* Dec. 1.
Niagara, details of construction,* April, 12.
Osceola, April, 35.
vs. torpedo boat destroyers, Aug. 15.
Steel, American for British shipyards,* Sept., 18.
Stern wheel steamers for the Yukon,* July 21.
Gypsy Queen,* Jan. 15.
Submarine boat Argonaut,* July, 7.
boats,* Captain Wm. H. Jaques, Dec. 14.
Tests of oil and coal as fuel,* Sept., 21.
Torpedo branch of U.S.N., faults in, Lieut.-Com'd'r W. W. Kimball, U.S.N., Dec., 27.
regulations U. S. criticism of, Lieut. A. P. Niblack, U.S.N., Dec., 28.
Torpedo-boat design, etc.,* H. G. Gillmor, U.S.N., Jan., 3.
destroyer Fame,* Jan., 1.
destroyer, Landsmans' trip on,* July, 24.
destroyers attacked by steam yacht,* Aug., 15.
proposed electric,* April, 20.
Torpedo-boats and destroyers, U. S., description of,* Nov. 21.
bids for, Sept., 35.
submarine, Dec. 14.
tactical employment of, Lt., W. L. Rogers, U.S.N., Dec. 29.
craft, discussions of, W. A. Fairburn, Sept., 10; Oct., 4.
U. S. contracts for, Oct., 26.
Tow barge Australia,* Feb., 10.
boats for Yukon river,* June, 1
Tramp steamer, first American,* [illegible]., 8; Nov., 1.
Transports for U. S.,* Aug., 12.
Trials of U. S. gunboats,* Nov., 5.
Triple-expansion engine, modern type of,* Sept., 1.
Tugboat for Great Lakes,* Feb., 17.
Turbine, "Parsons," method of reversing, April, 27.
steam, March, 26.
Turbinia and her performances, Feb., 28.
. S. composite gunboats,* Nov., 5.
sea-going battleships, July, 21.
torpedo-boats emergency, May, 7.
transports, liners converted into, Aug., 12.
Volunteer naval officers, appointments of, May, 8.
War material purchased by U. S., April, 8.
Warship Cristobal Colon, April, 8.
H. M. S. Fame,* Jan., 1.
O'Higgins, April, 8.
Pelayo,* June, 10.
U. S. S. Alabama launched, July, 15.
Amazonas, voyage of,* June, 16.
Cincinnati, April, 4.
Columbia in collision, July, 26.
Gloucester,* Aug., 15.
Kearsarge and Kentucky,* Feb. 11; May, 1.
Maine, report of Court of Inquiry,* May, 16; June, 25; Aug., 17; Sept., 24.
destruction of the,* March, 1.
Michigan, description of,* May, 13.
New Orleans,* April, 1; May, 29.
Oregon, maintaining steam on, Chief Engineer R. W. Milligan, U.S.N., Dec., 41.
Plunger,* Dec. 15.
Sylph,* Oct., 1.
White Star Liner, Cymric,* April, 12.
Wooden steamship Thomas Cranage,* June, 1.
Yukon river revenue cutter, May, 12.
steamers, fleet of,* July, 21.
towing steamers and barges,* June, 12.

† **NOTE.—The figures following the name of the month refer to page numbers. Illustrated articles are marked with an asterisk *) following the title.**

72495

PARAGRAPHS.

Allen liner Castillian, Feb., 33.
liner in collision, Jan., 32.
Alterations in lake S. Ss. Owego and Chemung, March, 37.
American liner New York, March, 37.
pig iron, Feb., 33.
Shipmasters' Association, Oct., 42.
Society Naval Engineers, meeting of Dec., 18.
Mechanical Engineers, meeting of, Dec., 44.
Anchor Line of St. Louis, March, 37.
Annual report Pacific Mail, Feb., 33.
Automobile torpedo, British, Jan., 31.
Awards to crew of S. S. La Champagne, May, 37.
S. S. St. Louis, April, 35.
Battleship Alabama launched, July, 15.
Battleships for U. S. Navy, Aug., 26.
Boston Fruit Co.'s steamers, Jan., 31.
British cruiser Powerful, Jan., 31.
engine room artificers, Feb., 33.
Royal Navy Reserve, Jan., 33.
T. B. D. Crane, Jan. 31.
torpedo-boat Empress, Feb., 33.
Cape Charles route steamer, Feb., 33.
Castle liner, Clyde built, Jan., 2.
Changes in steamship ownership, Feb., 33.
Coaling at sea., Feb., 33.
Collision between U. S. S. Columbia and Foscolia, July, 26.
Dry docks in Cleveland, Feb., 33.
Fire boat for New York, Feb., 33.
Flagler, S. S. Miami, Jan., 31.
Floating dry dock at New York, Feb., 33.
at Stettin, Jan., 2.
French naval programme, Jan., 31.
Hamburg-American freighter, Nov., 37.
liner, Feb., 33.
Harbor at Dover, Jan., 31.
Inspection vessel for U. S. engineers, Feb., 33.
Japanese cruisers Kasagi and Chitose, Feb. 21.
Lake steamer for Capt. John Mitchel, March, 37.
400 ft. long, Jan., 31.
George Morley, burned, Jan., 31.
Machine shop for Chicago Shipbuilding Co., March, 34.
Maritime Association of New York, July, 30.
Manhattan Steamship Co., March, 37.
Maryland Steel Co., Oct., 16.
Mexican Civil Engineers' Club, Oct., 37.
Multiple-screw ferryboat for Penna. R. R. Co., March, 37.
Neafie & Levy Co., reorganized, May, 37.
New shops of American Steel Barge Co., Feb., 33.
New vessels for Cuban mail, Feb., 33.
North Atlantic load line, Feb., 33.
Oil tank steamer built by Roach, March, 34.
Old Dominion S. S. Co., new vessels for, May, 37.
Parson's steam turbine, Jan., 31.
Polynesian S. S. Co., Sept., 28.
Port Arthur and Mexican S. S. Co., March, 37.
Prince Line to Italy, Feb., 33.
Puget Sound steamer, Feb., 33.
Queen Victoria's S. Y., machinery for, Jan., 32.
Record in discharging coal, Feb., 33.
Saint Louis barge line, Jan., 31.
Salvage case S. S. Circassia, Jan., 31.
Shipments of horses on the Atlantic, April, 35.
Shipyard at Portland, Ore., July, 32.
Signal tower at port of New York, Jan., 31.
Steamboat Onteora, March, 37.
Steamer for Northern S. S. Co., July, 32.
Old Dominion Line, April, 32.
Virginia and Carolina Chemical Co., March, 37.
Steam launch Ellide, Jan., 32.
Steamship Bulgaria, April, 32.
Horatio Hall, for Maine Line, April, 35; May, 37.
Maracaibo, loss of, Nov., 39.
Monarch in collision, Jan., 32.
Rapidan for American trade, April, 35.
Riojano, Jan., 33.
Rosedale ashore, Jan., 32.
Steamships Cymric and Pretoria, March, 37.
Ems and Gypsum Princess, July, 26.
Steam yacht Mayflower, March, 37.
Niagara, March, 37.
for P. A. B. Widener, Oct., 22.
for Prince of Monaco, Feb., 33.
Thingvalla Line, Jan., 31; Nov., 30.
Torpedo-boat MacKenzie, March, 37.
McKee, April, 35.
Transatlantic passengers landed at New York, March, 37.
Transpacific record, Feb., 33.
Transport service to Cuba, U. S., Sept., 27.
Twin-screw carferry for T. & A. A. R. R. Co., May, 37.
Volunteer naval officers, Nov., 21.
Westinghouse and Walker Companies Consolidate, Oct., 39.
White Star liner Britannic, Feb., 21.

DICTIONARY.

Air casing, Jan., 30.
chamber, Jan., 30.
cock, Jan., 30.
duct, Jan., 30.
gauge, Feb., 32.
lock,* Jan., 30.
pump,* Jan., 30.
Alarm valve, Feb., 32.
Anti-friction metal, Feb., 32.
Ash chute, Feb., 32.
cock, Feb., 32.
ejector,* Feb., 32.
hoist, Feb., 32.
pit, Feb., 32.
door, Feb., 32.
Atmospheric Line, Feb., 32.
Auxiliaries, Feb., 32.
Babbitt metal, Feb., 32.
Baffle plate, Feb., 32.
Bank fires, March, 34.
Bearing, March, 34.
bars, March, 34.
Bed plate, March, 34.
Bell crank, March, 34.
Bilge ejector,* March, 35.
injection, March, 34.
pump, April, 32.
suction, March, 35.
Black lead, March, 35.
Bleeder, March, 35.
Blow cock, March, 35.
down, April, 32.
Blower, March, 35.
Blow through, April, 32.
Boiler, April, 32.
casing, April, 34.
flue, May, 37.
hatch, May, 37.
mountings, Sept., 38.
seating,* May, 37.
trunk, May, 37.
tube, May, 37.
Boiling, May, 37.
point, June, 40.
Bolt,* July, 29.
Bonnet, June, 41.
Boss, Aug., 29.
Brace, June, 41.
Bracket,* Aug., 29.
Brass, June, 41.
Brazed joint, June, 41.
Brazing, June, 41.
solder, June, 41.
Breeches pipe, June, 41.
Breeching, Sept., 38.
Bridge wall, June, 41.
Bridle rods, June, 41.
Brine, Aug., 29.
cock, Aug., 29.
pump, Aug., 29.
Bronze, Aug. 29.
Bucket, Aug., 29.
Bull ring, Sept., 38.
Bunker, Aug., 29.
Bushing, Aug., 29.
Butt joint of seam,* Aug., 29.
weld, Aug., 29.
By pass, Aug., 29.
Calorimeter, Sept., 38.
ratio, Sept., 38.
Carbonic acid, Sept., 38.
Carbon-monoxide, Sept., 38.
Caulking,* Sept., 38.
Centrifugal pump, Sept., 39.
Channel plate, Sept., 38.
way, Sept., 38.
Check valve, Sept., 39.
Chute, Sept., 39.
Circulating pump, Sept., 39.
Circulator, Sept., 39.
Circumferential joint, Sept., 39.
Clearance, Sept., 39.
Coal, Sept., 39.
Coal heaver, Sept., 39.
Coaling, Sept., 39.
port, Sept., 39.
Cock, Oct., 39.
Collapse,* Sept., 39.
Collar, Sept., 39.
Column,* Oct., 40.
Combustible, Oct., 40.
Combustion chamber, Oct., 40.
Compound engine, Oct., 40.
Compression, Oct., 40.
Concentration, Oct., 40.
Condenser,* Oct., 40.
Condenser tube, Oct., 41.
packing,* Oct., 41.
Connecting rod, Nov., 45.
Consumption of steam, Nov., 45.
Cooling surface, Oct., 41.
Corrosion, Oct., 41.
Corrugated furnace,* Nov., 45.
Counter, Nov., 45.
Counter bore, Nov., 46.
sunk bolt,* Nov., 46.
Coupling * Nov., 46.
flange, Nov., 46.
Crank,* Dec., 49.
Crank Pit, Dec., 49.
Crank Shaft, Dec., 49.
Crosshead,* Nov., 46.
Crow foot, Nov., 46.
Crown bar,* Nov. 46.
sheet, Nov., 46.
Cut-off, Nov., 46.
Cylinder,* Nov., 46.
Damper, Dec., 50.
Dash Plate, Dec., 50.
Dash Pot,* Dec., 50.
Dead-Centers, Dec., 50.
Dead Plate, Dec., 50.
Delivery, Dec., 50.
Diaphragm Plate, Dec., 50.

LITERATURE.

Arithmetic of the steam engine, E. S. Gould, March, 39.
Beeson's Marine Directory, July, 34.
Blue Book of American Shipping, Sept., 41.
Book of the Ocean, Ernest Ingersoll, Dec., 52.
Catechism of the steam plant, Nov., 48.
Coast Defence Edition Scientific American, Aug., 34.
Development torpedo-boat destroyer, June, 6.
Drawing and Designing for Marine Engineers, C. W. Roberts, Aug., 33.
Electricity, German handbook on for marine use, May, 38.
Electric Lighting for Marine Engineers, S. F. Walker, Aug., 33.
Engineering Laboratory Practice, R. A. Smart, Nov., 49.
Engineers' Reference, March, 36.
Fatigue of Metal, F. H. J. Porter, May, 39.
French studies of marine warfare, Aug., 32.
Gas, gasoline and oil vapor engines, June, 42.
German Navy Atlas, Nov., 49.
Heat Efficiency of Steam Boilers, Bryan Donkin, M.I.C.E., Dec., 52.
High pressure hydraulic fittings, March, 38.
Index to Journal of American Society Naval Engineers, Aug., 34.
Indicator handbook, C. N. Pickworth, Nov., 49.
Manning's Yacht Register, Aug., 33.
Manual of Laying Off, Wilson's, Aug., 32.
Marine Engineers and How to Become One, E. G. Constantine, June, 42.
Marine Review, annual report, March, 39.
Marine steam engine, Sennett and Oram, May, 38.
Master's Manual, Sept., 42.
Mechanical Draft, Sturtevant Company, March, 39.
Model Engines and Small Boats, M. N. Hopkins, May, 39.
Nation's Navy, The, Charles Morris, Dec., 52.
Naval Engineers, F. G. Burton, July, 33.
Navy and Army, Illustrated, London, Sept., 42.
Navy in the Civil War, U. S., Soley, Ammen, Mahan, Dec., 52.
Practical advice for marine engineers, July, 33.
"Practical Engineer's" pocket book, Jan., 31.
Record of American and Foreign Shipping, Jan., 33.
Reed's Hints to Sea-Going Engineers, June, 42.
Reference Catalogue, Scientific American, March, 39.
Refrigerating and Ice Making Machinery, A. J. Wallis-Taylor, Aug., 34.

LIBRARY U. S. PATENT OFFICE DEC 12 1898

Refrigerating Machinery, A. Ritchie Leask, July, 33.
Resistance and Propulsion of Ships, W. F. Durand, May, 39.
Scientific American Naval Supplement, July, 33.
Transactions S. N. A. & M. E. for 1897, May, 38.
Triple and Quadruple Expansion Engines, A. R. Leask, Aug., 33.
U. S. Standard Register of Shipping for 1898, May, 39.
Valve diagram chart, Lunkenheimer Co., Dec., 52.
Valve setting Record Book, P. A. Low, March, 39.
Verbal Questions and Answers, Nov., 37.

QUERIES AND ANSWERS.

Air for combustion, Oct., 42.
Bilge keels, effect of, June, 40.
Boiler braces, marine,* May, 35.
Scotch, proportions of, Aug., 30.
"B. T. U." explained, Jan., 33.
Coal to produce one horse power, Feb., 34.
Co-efficient of fineness, April, 32.
Compound engine cylinders, Oct., 42.
Corrosion in jet condenser, Feb., 34.
Crank pin travel, Sept., 41.
Displacement too fine, Sept., 40.
Distance stay bolts, Nov., 47.
Dock trials,* Sept., 40.
Drilling vs. punching, Oct., 42.
Economy of high pressure steam, Jan., 33.
Engine clearance, Nov., 47.
Feed heater in smokestack, March, 36.
water inlet, April, 32.
Governors for marine engines, Oct., 41.
Great Eastern, dimensions of, June, 39.
Horse power per ton of machinery, Jan., 32.
How to clean a dynamo, Jan., 32.
Indicator cards worked out, May, 36.
Invisibility of steam, Feb., 34.
Jackass purchase,* Aug., 30.
"Lead" and "throw" of the eccentric, Feb., 34.
Loss of horse power in towing, March, 35.
Marine engineer's license, Jan., 33.
Motion of beam in paddle engine, Feb., 34.
Oilers on American Line boats, March, 36.
Power required for given speed, Nov., 48.
Pressure and weight, Sept., 10.
Pump cylinders, Nov., 47.
Qualifications of U. S. machinist, Jan., 33.
Ratio steam and exhaust pipes, Nov., 47.
Rule for finding pitch of propeller, March, 36.
Safety valve problem explained,* June, 40.
Screw propeller, materials for, April, 32.
Setting of spring loaded safety valve, Jan., 32.
Sizes of cylinders of quadruple-expansion engines, July, 31.
Soot deposit in boilers, March, 35.
Stroke of high speed engines, Jan., 32.
Testing bituminous coal, Jan., 32.
Thickness copper pipe, Jan., 33.
Triple-expansion to replace high pressure engine, June, 39.
U. S. battleship data, April, 32.
Velocity of flow in pipes, Feb., 34.
Warship Dunderberg, Jan., 33.
Water gauge pressure, Feb., 34.

EDITORIAL.

Admiral Dewey at Manila, June, 34.
Assignment of St. Louis Anchor Line, Feb., 24.
Board of Inquiry into loss of U. S. S. Maine, March, 24.
British shipbuilding returns for 1897, Feb., 25.
Carnegie's (Andrew) shipyard proposition, April, 26.
Congressional indifference to naval conditions, May, 28.
Domestic shipbuilding returns, Nov., 35.
Failures of British vessels, Jan., 24.
First American tramp steamer, Jan., 25.
Gunnery at Santiago, Oct., 30.
Hospitals on ships, Sept., 33.
Incidents in Spanish war, Aug., 23.
Longitudinal bulkheads, Oct., 30.
Loss of Atlantic liner Veendam, March, 25.
battleship Maine, March, 24.
Marine gas motors, July 22.
Meeting of the Engineers' Beneficial Association, Feb., 25.
S. N. A. & M. E., Nov., 34,* Dec., 20.
Naval fight at Santiago, Aug., 22.
Paris Exposition, 1900, Sept., 33.
Power necessary to stop a vessel quickly, April, 27.
Practical experience vs. science in ship work, June, 35.
Professional secrecy amongst engineers, Jan., 25.
Progress in marine construction, Feb., 24.
Racing on the Atlantic, Jan., 24.
Roach claim paid, May, 28.
Roosevelt, Theodore, resignation of, May, 29.
Saving life at sea, Dec. 20.
Shaft breakage S. S. Paris, May 29.
S. S. La Bourgogne, loss of, Aug., 23.
Staff officers U. S. Navy, July, 22.
Torpedo-boats and destroyers, U. S., June, 35.
destroyers built by Lairds, Aug., 23.
Torpedo equipment of U. S. S. Maine, March, 25.
Trade in Cuba, Philippines and Porto Rico, Sept., 32.
U. S. S. New Orleans, equipment of, May, 29.
World's shipbuilding returns, Oct., 31.

IMPROVED APPARATUS.

Armor plate, McAllister system,* May, 26.
Asbestos fire board,* Sept., 30.
Blower and "Forbes" engine,* Dec., 19.
Boiler compound feeding device,* April 23.
Compound engine,* Oct., 29.
Course indicator,* Sept., 30.
DePuy leg boiler,* March, 23.
Electric gig for steam yacht,* Feb., 22.
Feed water filter,* April, 24.
Flexible shaft and motor,* Oct., 28.
Gate valve, high pressure,* Oct., 27.
Generating sets, C & C,* Nov., 31.
"Sturtevant,"* Dec. 19.
Grate bar, "Gadey,"* March, 23.
Launch motor, "Truscott,"* Jan., 22.
Marine engine, "Twiss,"* Feb., 22.
Marine binoculars,* Sept., 31.
Metallic packing, flexible,* Sept., 30.
"Rigby.," Dec., 18.
Motor boat, "King,"* Feb., 23.
Oil distributing projectile,* Jan., 22.
filter, "Cross,"* April 23.
Pipe covering, "Gast's" brine,* May, 26.
threading machines,* April, 24.
wrench, "Vulcan" dropped forged,* Aug., 20.
Pocket electric light,* Oct., 27.
Pumps for lake steamer,* Nov., 32.
Reducing valve, Eclipse steam,* June, 33.
Safety valve, "Scott,"* Nov., 31.
Search light, acetylene gas,* June, 33; Dec., 18.
electric,* Aug., 20.
Separator and dry pipe,* Jan., 23.
Steering engine, "Waters,"* Nov., 31.
Traveling ramps,* Oct., 27.
Triple-expansion engine, "Ward,"* Aug., 21.
Twist drill grinder,* Aug., 20.
Valve, "Eclipse," blow-off,* April, 23.
Water-tube boiler, "Carpenter,"* Feb., 21.
"Detroit,"* Jan., 22.
"Lumgair,"* Feb., 21.
"Watson," radial,* July, 20.
Wrecking pump, "Snow,"* April, 24.

PATENTS.

Anchor,* Dec., 53.
Boat,* Sept., 41.
Chain propeller,* Dec., 53.
Diving apparatus,* Aug., 31.
Electric alarm, water column,* Sept., 41.
Engine controlling device,* Dec., 53.
Marine screw propulsion,* April, 35.
Metallic packing,* April, 35.
ring packing,* Feb., 35.
Oil cup,* Feb., 35.
Pressure gauge, "Crosby,"* March, 38.
Schlick system of balancing engines,* June, 41.
Steam boiler, marine,* Aug., 31.
gauge, "Almy,"* March, 38.
generator, "Ferrand,"* March, 38.
steering gear,* Sept., 41.
Submarine boat,* Aug., 31.
Watertight doors,* Feb., 35.

OBITUARY.

Coyle, John B., Dec., 53.
Crofts, John J., Feb., 34.
Dialogue, John H., Nov., 42.
Dowd, Thomas F., June, 42.
Emery, Dr. C. E., July 33.
Forbes, J. M., Nov., 42.
Gause, H. T., Dec., 53.
Inch, Philip, Nov., 42.
Keely, J. W., Dec., 53.
Mehan, Niven C., July, 33.
Mudd, Thomas, July, 33.
Neafie, Jacob G., Feb., 34.
Pankhurst, John F., July, 33.
Perry, Nelson W., April, 18.
Platt, James, Feb., 34.
Plimsoll, Samuel, July, 33.
Southworth, Hiram G., Feb., 34.
Williams, Owen, Feb., 34.

CORRESPONDENCE.

"B. T. U.," Jan., 27.
Destroyers, specifications for U. S., Aug., 26.
Estimated weights of machinery, June, 37.
Indicator diagrams, inquiry about,* May, 30; June, 36-37.
Marine engine repairs, Nov., 36.
Naval promotions, Sept., 35.
Oil saving device,* Jan., 27.
Propeller blades, phenomenon in, May, 30.
position of, Jan., 27; Feb., 27.
Tail shaft breakages, May, 32.
Turbinia and her performances, Feb., 28.
Walschaert valve gear,* Jan., 26-27; Feb., 28; March, 30; May, 30.

ERRATA.

March, page 6, (U. S. S. Maine), 2nd column, 15th line from bottom, *for* 0.878 ft. *read* 0.878.
page 27, (Parson's turbine), 1st column, *line dropped* between 12th and 13th line from bottom *should read:* electric generator.
May, page 29, (Editorials), 2nd column, 21st line from bottom *for* two 6-in. guns *read* four 6-in. guns. 10th line from bottom, *for* Spanish *read* Portuguese.
page 36, (Queries & Answers), middle of 1st column, 1st *paragraph* commencing (2) and the following paragraph commencing Ans., are incorrect and superfluous. These *should be skipped* in reading the "examples."
June, page 41, head of 1st column, Fig V, following the words Engineers' Dictionary, *should read* VI.
July, page 11, 1st column, foot note, *for* Army and Navy *read* Navy and Army, illustrated. Same applies to subscription under cut on page 25.
August, page 23, (Editorial), 2nd column, 24th line from top, *for* St. Louis *read* St. Paul.
September, page 35, 1st column, (Engines S. S. Manitou), 12th and 15th lines from the top, *for* intermediate *read* high pressure; 19th and 20th lines from the top, *for* high pressure cylinder *read* intermediate cylinder.
page 35, (Bids for torpedo boats and destroyers). *For corrected list* see November issue, pages 28 and 29.
October, page 19, (Report on Infanta Maria Teresa), 2nd column, *lines dropped* from bottom of column *should read:* "of the Infanta Maria Teresa are standing. The foremast has fallen aft and now lies along starboad gangway. It is recommended that the vessel be immediately secured by cables, so that she cannot be moved from her present position.
November, page 32, 2nd column, (Description Dean pumps), 11th line from bottom, *for* 13 in. *read* 18 in.
page 45, (Engineers' Dictionary), 2nd column, 6th and 7th lines from bottom, *for* "Fox," "Morison" and "Purves" *read* "Fox," "Purves" and "Morison."

LIBRARY
JAN 10 1898
U. S. PATENT OFFICE

MARINE ENGINEERING.

Vol. 2. NEW YORK, JANUARY, 1898. No. 1.

H. M. S. FAME A RECENT TYPE OF BRITISH TORPEDO-BOAT DESTROYER.

An up-to-date British torpedo boat destroyer, H. M. S. Fame, is shown in the engraving reproduced from a photograph taken during her trial trip. The mean of her three-hours run was 30.168 knots, with 5,850 I. H. P. This boat is one of a group of eight built for the Admiralty by John I. Thornycroft & Co., of Chiswick, London. On trial these boats proved to be extremely handy and fast. Although going at a high rate of speed, it will be noticed that the trim of the boat is not much altered, nor does she kick up much of a fuss in the water. The general dimensions are: Length, 208 ft. on the water line, 210 ft. over all; maximum breadth, 19 ft. 6 in.; depth, 13 ft. 6 in. The load draft is about 5 ft. 10 in. forward, 7 ft. aft and the displacement about 272 tons. The weight of the propelling machinery is nearly 128 tons. The engines are of the Thornycroft type, triple-expansion, with piston valves and cylinders 20 in., 29 in. and two 30 in. dia., and 18 in. stroke. At full speed they make slightly less than 400 turns. There are three boilers of the Thornycroft type, with 66 ft. grate surface and 4,000 ft. heating surface, worked at a pressure of 205 pounds

H. M. TORPEDO-BOAT DESTROYER FAME DOING 30.168 KNOTS WITH 5,850 I. H. P.

per sq. in. At top speed the coal consumption is 2.43 pounds and at low speed 1.67 pounds.

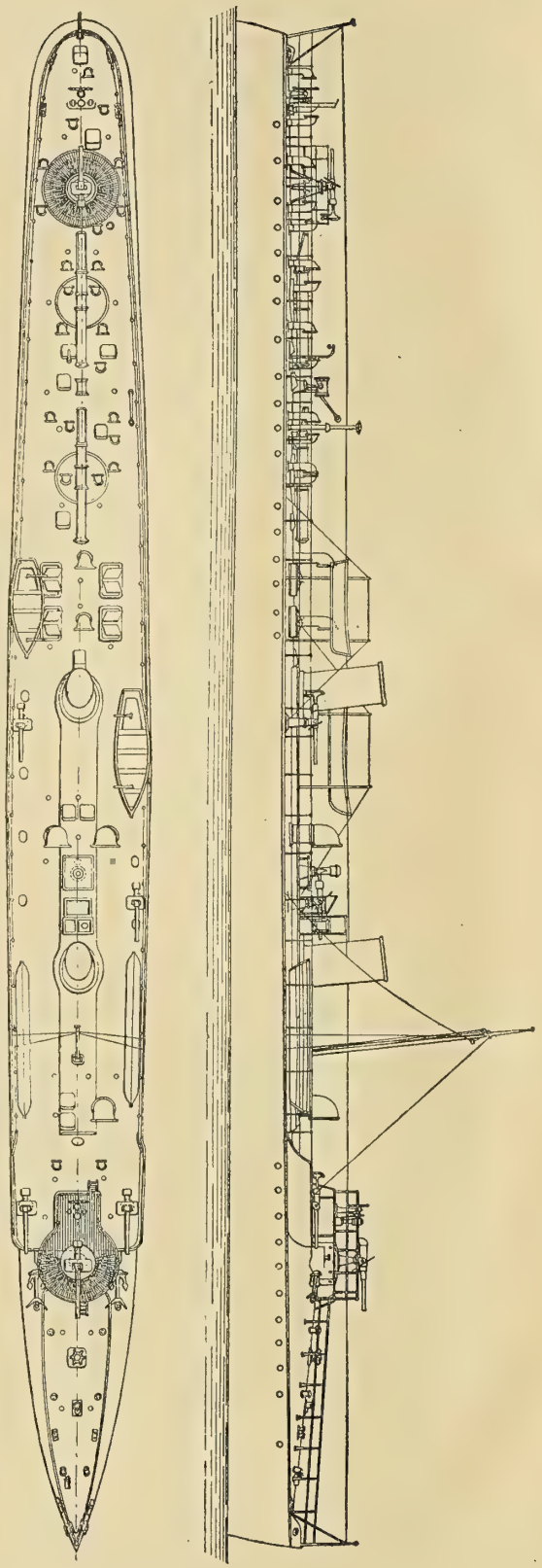
In the construction of this group of boats light scantlings of high grade steel were used to secure lightness. This material had a tensile strength of about 40 tons to the square inch and an elongation of 15 per cent in 10 in. The increased strength and stiffness was secured by the use of a new alloy. A feature of the design is the form of bow, which slopes forward from the water line, and, as the sides are flared very much forward, the boat is comparatively dry even when steaming fast to the wind. The cutwater is also very fine. The boat is fitted with one 12 pounder R. F. gun and five 6 pounder R. F. guns, and two revolving torpedo tubes, for 18 in. Whitehead torpedoes. She has no bow discharge.

Just abaft the conning tower there is a navigating bridge, which permits of the working of the boat in the open, even in dirty weather. The stern is cut away in the usual Thornycroft style, the floor being arched, so that the propellers work in a "solid" body of water even in very rough water. As will be noticed, there are only two smoke pipes, the forward of which gives an outlet to two boilers, which are placed back to back. The after stack, which is outwardly the same size, serves, not only as a smoke pipe for the remaining boiler, but as a means of ventilating the engine room, the hot air passing up between the inner pipe and the outer casing.

The boats' complement is fifty-six. Some of the crew are berthed forward under the turtle back and others aft of the machinery space. The officers' quarters are right aft, in the traditional though not the most comfortable position.

A new Castle liner for the English-South African mail service, to be built at the Fairfield Works on the Clyde, will have quadruple-expansion engines of 9,000 horse power, with a working pressure of 205 lbs. per sq. in.

A large floating dry dock capable of lifting a 15,000 ton vessel has been ordered by the Vulcan Shipbuilding and Engineering Co., of Stettin, from C. S. Swan & Hunter, of England. The first use which will be made of this dock will be the lengthening of the North German Lloyd liners Spree and Havel. These ships are about six years old. They are now 463 ft. long, 51 ft. 10 in. beam and 37 ft. deep. An additional 65 ft. will be built in amidships, bringing the length up to 528 ft. A more radical change, however, will be the substitution of two sets of engines driving twin screw for the single engines and screw of each vessel. The present engines are of the five-cylinder, three-crank triple-expansion type, indicating about 11,500 horse power. The new engines will be four-cylinder, four-crank triple-expansion, each vessel having about 18,000 horse power. Three new boilers will also be fitted in each vessel. An extra knot and a half is expected as a result of the alterations.



H.M.S. FAME, ONE OF A GROUP OF EIGHT THORNYCROFT TORPEDO-BOAT DESTROYERS BUILT FOR THE BRITISH NAVY.

ON TORPEDO-BOAT DESIGN WITH SUGGESTIONS FOR HARBOR-DEFENSE AND SEA-GOING TYPES.*

BY ASST. NAVAL CONSTRUCTOR H. G. GILLMOR, U. S. N.

The torpedo as an offensive weapon made its appearance during the war of the rebellion from '60 to '65, and, by its achievements during that war, established itself as a factor to be considered in naval warfare. So many and so brilliant had been the successes which were achieved through its use in this war that it was almost immediately taken up by the maritime powers of Europe and became a recognized naval offensive weapon.

The torpedo of that time was the spar-torpedo; which, being carried at the end of a spar 20 to 25 ft. long., capable of being rigged out and in and placed at various angles, could be brought in contact with the bottom of the enemy's vessel by a pulling boat or a steam-launch and discharged by means of an electrical connection. For success it was necessary to come alongside the enemy before discovery and disablement. The rapid-fire gun of small caliber and the searchlight were not then in existence, so that the task of the torpedo in the hands of fearless men was, on a dark or foggy night, less impossible than might be thought.

For some years the torpedo remained as it was at the close of the war—the weapon of the regular pulling boats and steam launches of the man-of-war. Boats which in time of peace did duty as the regular running boats of the ship were provided with apparatus for the use of the spar-torpedo in time of war as a part of their equipment. Early in the seventies it was proposed to construct small special steam vessels, in which a lightness of hull, fineness of lines, and exceptionally large motive power would insure a speed of from 15 to 18 knots, for use as torpedo-boats. A little before this the Whitehead torpedo had been introduced and was being experimented with by all the European Powers. It was destined to revolutionize ideas of torpedo warfare and make more necessary the construction of the special torpedo vessels then proposed.

It is in England, in the yards of Messrs. Thornycroft and Yarrow, that special torpedo-boat construction was begun, and it is there that the torpedo-boat has become the very high-speed vessel that we possess to-day. The rivalry which has existed in the first instance between these two builders, and later among an increasing number of builders, has had quite as much to do with the development of the present types of torpedo-boats as have considerations of their warlike purpose and efficiency as means of offense. We are to-day accustomed to hear torpedo-boats spoken of as "20-knotters," or "30-knotters," as if speed, regardless of size, cost, number of men involved, offensive power, etc., were the one consideration in such vessels; and there is no doubt that in the popular mind a 30-knot boat must be far superior to a 20-knot or a 24-knot boat, no matter what may be the relations existing between other qualities of the two boats.

Messrs. Thornycroft built, in 1873, at their yards in Chiswick, to the order of the Norwegian government, the first special torpedo-boat constructed. This vessel, which was subsequently named the Wasp, was 57 ft. long, 7 ft. 6 in. beam, with a displacement of about 7 1-2 tons and a speed of about 15 knots. She was originally provided with an apparatus for the towing torpedo. France began, under the programme of January 30, 1875, the construction of torpedo-boats subject to the following limitations: Length, about 20 meters (75.6 ft.); hull of steel capable of resisting musket fire; maximum speed, 14 knots; sufficient coal for 8 hours at full speed. Our own government, in 1876, ordered a large wooden launch, the Lightning of the Herreshoff Manufacturing Co. She was 58 ft. long; was fitted with spar-torpedoes, and made about 17.5 knots on trial. In 1877, the Lightning, the first English torpedo-boat, was delivered by Messrs. Thornycroft to the English government. She was 85 ft. long and 11 ft. beam, with a displacement of 27 tons and made 19 knots on trial. The same year, the Russian government had no less than 100 boats of a similar character under construction at the Baltic works. These boats were 75 ft. long, 10 ft. beam, with a speed of 18 knots. Italy followed the next year with a vessel very much like the Lightning. About the same time the first German torpedo-boat was constructed. It was rather larger than the English and Italian boats. By the end of 1878 the torpedo-boat had a place in the navy lists of the European Powers.

About the time of the beginning of the construction of special torpedo-boats, the Whitehead torpedo had made such progress as to find some advocates for its use. From the uncertainties attending the action of the early automobile torpedo and the demonstrated efficiency of the spar-torpedo under the existing conditions, the latter was in many instances preferred to the former, and most of the early torpedo-boats were originally provided with spar-torpedoes and later fitted for the use of the automobile torpedoes. The introduction of the rapid-fire gun was the death-blow of the spar-torpedo and emphasized the necessity for high-speed torpedo vessels for use with the automobile torpedo. The torpedo itself, and the means for firing it, were rapidly improved. The growth and improvement in the torpedo-boat more than kept pace with its principal weapon.

From 1878 on, the work of construction of special torpedo vessels by the European Powers has gone on steadily, although, in the case of individual nations, there have been delays from indecision as to the types which should be taken up. An enlargement in the sphere of the tor-

*From a paper read before Society of Naval Architects and Marine Engineers, at the Fifth General Meeting.

pedo-boat, by which it was to prove its title to consideration as a separate branch of navies rather than one of the weapons of ships, was marked by the construction of sea-going torpedo-boats, of which the Batoum, completed in 1879 for Russia, was the first.

At the end of 1884, Russia possessed 115 torpedo-boats; France, 50; Holland, 22; England, 19; Italy, 18, and Austria, 17. At the end of the year 1890, France possessed 210 torpedo-boats; England, 206; Italy, 152; Russia, 143; Germany, 125; Japan, 24, and Spain, 15. The Cushing, the first United States torpedo-boat, was that year commissioned.

That we, the nation which of all nations had had the largest practical experience with torpedoes in actual warfare, should have been the last to take up the torpedo-boat—which, after all, was but the logical application of our own war experiences to altered conditions and improved weapons—was doubtless due, in the first instance, to the attitude of Congress toward the Navy, and its unwillingness to appropriate money for rebuilding and modernizing that important arm of the national defense, rather than to any lack of enterprise or foresight on the part of officers of the Navy. When public sentiment changed and Congress turned its attention to the needs of the Navy, demands for the larger modern ships seem to have been so urgent as to have kept the torpedo-boat out of notice, although, just at that time, large expenditures were being made by the European Powers for this class of vessel.

From the time of the construction of the torpedo-launch Lightning in 1876, nothing was done toward providing torpedo-boats for the Navy until 1888. That year the Navy Department purchased from the Herreshoff Manufacturing Co. a fast wooden yacht, the Stiletto, 86 ft. 6 in. long, 11 ft. beam, and about 31 tons displacement, with a speed of 18 knots. After some changes were made this vessel was fitted as a torpedo-boat, for use in experimental work at the torpedo station in Newport, where she is still in service. The first modern torpedo-boat to be added to the navy was the Cushing, built by the Herreshoff Manufacturing Company, for the Navy Department, and commissioned in 1890. She was of galvanized steel throughout, and at the time of her completion, was a good example of current practice. The same year Torpedo-Boat No. 2, the Ericsson, was appropriated for.

In 1894 the work of torpedo-boat construction was taken up in earnest. In July of that year appropriation was made for three boats 160 ft. long and of 140 tons displacement, with a speed of 24.5 knots. The succeeding Congress made provision for three more of still larger size and higher speed. In June, 1896, Congress provided for the construction of three torpedo-boats having a speed of 30 knots, and appropriated $500,000 for the construction of not more than ten torpedo-boats of lower speed. Under this second provision, contracts were entered into by the Navy Department for the construction of three boats having a speed of 22 1-2 knots and four boats having a speed of 20 knots. Of the three 30-knot boats provided for, two are of small size and the third similar to the English torpedo-boat destroyers. The next Congress authorized the construction of three more 30-knot boats, all of the large size designated in the English service as torpedo-boat destroyers. In Table I will be found such particulars as the names of the builders, dimensions, etc., as well as such data of design as are to be had for all these boats. An inspection of the table will disclose the wide variation in design which exists among the boats which we have built and are building. (The table containing this data will be found on the opposite page.)

Of the hundreds of foreign torpedo-boats built and building, there is not the space for a mention of even the most important. In Table II there have been arranged all the available data regarding the dimensions, armament, weights, etc., as well as the general data regarding the machinery and boilers of some of the more prominent of these. It is believed that the data given are accurate, except that the displacements given for some of the English torpedo-boat destroyers are only approximately the displacements on the trials for which the I. H. P. and speed are given.

At the end of the year 1896 the leading maritime powers possessed in serviceable condition, were building, or had projected torpedo-boats in the following numbers and sizes:

Lengths.	England.	France.	Russia.	Italy.	Germany.	Japan.	Spain.	U. S.
Less than 100'...	64	28	95	21	—	4	5	1
100' to 125' inc...	57	161	16	40	25	66	12	4
125' to 150' inc...	39	62	105	110	107	35	28	7
150' to 180' inc...	—	3	4	9	25	—	—	6
More than 180'..	102	—	4	1	11	11	11	4
Totals.....	262	254	224	181	168	116	56	22

The figures illustrate the growth in a score of years of a branch of naval armament and the advance in ideas which has been made in that time as to the importance and utility of the torpedo-boat. In order that the extent of the change which has been worked in the torpedo-boat itself in the same period may be the more readily realized, boats of English construction of several of the years of this period have been arranged in Plate I (page 7) in order.

The Naval Architect, arraying the achieve-

TABLE No. I.

DIMENSIONS AND OTHER DATA FROM TORPEDO-BOATS OF THE UNITED STATES.

Name.	Date.	Length.	Beam.	Draught.	Displacement.	Armament.	Torpedo Tubes.	Designed speed.	Trial speed.	Designed I. H. P.	Trial I. H. P.	Weight of hull.	Weight of propelling machinery.	Trial load.	Bunker capacity.	Economical radius.	Diameter of Cylinders. H. P.	Diameter of Cylinders. I. P.	Diameter of Cylinders. L. P.	Stroke.	Revolutions.	No. of boilers.	Kind of boilers.	Grate surface, each boiler.	Heating surface	Boiler pressure.	Weight of engine, condenser, etc.	Weight of boiler, water and fittings.	No. of screws.	No. of blades.	Pitch.	Diameter.	Blade area.	Slip per cent.	Piston speed.	Remarks.	Builders.
Cushing	1890	137'.5	14'.25	4'.875	105.3	3 1-pdrs.	1 18-in. bow 2 on deck	22	22.53	1750	Est'd 1760	33.7	54.5	17.3	39		Quadruple expansion 11½"	16" 24½ Quadruple.	22½"	15"	375	2	Thornycroft.	38.65	2253	235	34.0	20.50	2	4	8'.417	4'.3"	9.3 projected. 6.3 helicoidal.	27	935		Herreshoff Mfg. Co.
Ericson	1891	150' 0"	15' 6"	4' 9"	120	4 1-pdrs.	3 18-in. 2 deck 18"	24		1800		49.20	58.46	17.5	35		11½"	18"	30"	16"	385	2	Thornycroft.	42.5	2369	250			2	3	7' 8"	4' 9"	8.5 helicoidal.	19.84	1026		Dubuque Iron Works.
Nos. 3, 4, and 5	1893	160' 0"	16' 0"	5' 0"	143.9	3 1-pdrs.	3 18-in.	24½	24.56	2000		53.1	50.82	30.5	44		12"	19½"	25"	16"	398.77	3	Mosher.	45.5	2630	240½	31.69	19.20	2	3	7' 10"	5' 2"	9.68 projected.	19.84	1056		Columbian Iron Works.
No. 6					165.				28.38										25"		398						42.59	34.30							1037		
No. 7	1893	175'.5	17' 6"	6' 9"		3 1-pdrs.	3 18-in.	27½	28.38	3400																											Herreshoff Mfg. Co.
No. 8	1895	176'.0	17'.0	5' 6"	184	4 1-pdrs.	3 18-in.	26		3300		66.5 Est'd	76.8 Est'd	29½	60		16"	25"	35½"	16"	395	3	Mosher.	47	2630	250	40.59 Est'd	34.30 Est'd	2	3	9'	5' 4"	7.1 heliocidal.	11.32		Not yet completed. Elements given are as designed.	Moran Bros.
Nos. 9 and 10	1896	147'	16' 4½"	4' 7½"	143.3	4 1-pdrs.	3 18-in.	30		4200		44.55	58.20	20.39	33		17½"	24½"	37"	21"	340	2	Normand.	55	2580 3400 outside	250	56.5 Est'd 47.55	30.65 Est'd 30.65	2	4	10' 8"	6' 4"				do.	Bath Iron Works.
No. 11	1896	215'	20'	6'	240	6 6-pdrs.	2 18-in.	30		5600	Est'd 820		Est'd 120	55	80		20"	29"	30"	18"	400	3	Thornycroft.	66	4000	240	63.51	56.49	2	3	8' 9"	6' 9"	6.9 projected.			do.	Union Iron Works.
Nos. 12 and 13	1896	146'	14' 6"	5'.17	110.4	3 1-pdrs.	3 18-in.	28½		1750	Est'd 57.1		Est'd 48.7	20	40		11½"	19"	22½"	15"	395	2	Thornycroft.	74	2426	250	Est'd 30.32	Est'd 26.78	2	3	7' 3"	4' 10½"	8.5 developed.			do.	Wolff & Zwicker.
No. 14	1896	139'	15'	4' 1"	103	3 1-pdrs.	3 18-in.	28½		1750			48.6 Est'd	20	38	2300	12½"	18"	25"	13½"	410	3	Du Temple.	40	1932	225			1						do.	Herreshoff Mfg. Co.
Nos. 15 and 16	1896	120'	12'	3' 2½"	46½	1 1-pdr.	2 18-in.	20		850			21.7	10½	8	1000	12½"	19½"	25"	13½"	400	1	Du Temple.	38	1850	225			1						do.	Herreshoff Mfg. Co.
No. 17	1896	101' 6"	12' 6"	4' 3"	65	1 1-pdr.	2 18-in.	20		850							12"	19½"	22"	16"	350	2			2100	250			2						do.	Hillman & Sons.
No. 18	1896	101½'	12' 6"	4' 3"	65	1 1-pdr.	2 18-in.	20		850							12"	19½"	22"	16"	350	2			2100	250			2						do.	Columbian Iron Works.
No. 19	1897	225'	21'.3	6' 6"	340	6 6-pdrs.	2 18-in.	30		7200				60			21".5	31".5	34"	18"	400	4	Thornycroft.	67.8		240			2						do.	Harlan & Hollingsworth.
No. 20	1897	191' 8"	20' 2"	5' 0"	240.5	4 6-pdrs.	2 18-in.							41.6	131		19".5	31".75	35"	18"															do.	Wolff & Zwicker.
No. 21	1897	205'	18' 3"	6' 0"	235	4 6-pdrs.	2 18-in.			5000				41.5			20"	29"	30"	18"	400		Seabury			245									do.	Gas Engine & Power Co.

ments in torpedo-boat construction of the last two decades, is justified in his feeling of self-satisfaction at the results which have attended his struggles with difficulties and the proofs which they bring of his ability, by the careful and scientific application of his skill, to overcome great difficulties. The Marine Engineer may look with deserved pride upon the giant strides which he has made in these few years in passing from the 90 horse-power compound engine and locomotive boiler of the first torpedo-launch, to the 6,000 horse-power quick-running engine and the water-tube boilers of the latest torpedo-boat destroyers, as irrefutable testimony to his energy and ability. Satisfactory as this progress is from an engineering point of view, those who would look upon the torpedo-boat as a weapon provided for a definite serious purpose must investigate the progress in its bearing upon the efficiency of the boat for that purpose. Assuming the desirability of the latest types for the nation originating them, is there anything in our own circumstances which makes advisable the acceptance of the same types by us?

The object for which torpedo-boats are constructed is the destruction of vessels of the enemy. It is intended that a vessel costing a few thousands of dollars and manned by a handful of men shall attempt the destruction of vessels costing hundreds of thousands of dollars, carrying hundreds of men. The condition of equalization which comes in to give the immeasurably weaker unit a chance of success against the cruising ship is the secrecy of action possible under cover of darkness or fog. For the secrecy of action and immunity from discovery upon which success is contingent, the torpedo-boat depends upon the visible surface which she presents. It is her small size which enables her to creep upon her antagonist and deal the deciding blow. Early discovery means to her failure always, and probable destruction. The protection of the torpedo-boat lies primarily in her size. In her secondary role of protector of the fleet against torpedo-boat attack, she is also dependent upon her size for success. To destroy, she must discover, and to discover the torpedo-boats making a stealthy approach it is necessary that the size and visible surface of the guarding boat should not be so greatly superior to that of the attacking boats that they may make her out in time to avoid her. The modern torpedo-boat destroyer, by its large size and attendant visibility, will, under the circumstances which are admitted as possible for torpedo-boat attack, defeat its own purpose.

The purposes for which we require torpedo-boats naturally divide them into two large classes—the seagoing and the harbor or coast-defense. This division, while not directly recognized in the classifications of torpedo-boats by the various nations, is accepted in the division of duties to which boats already constructed are considered assignable, and is implied in all the

TABLE No. II.

DIMENSIONS AND OTHER DATA FROM RECENT FOREIGN TORPEDO-BOATS.

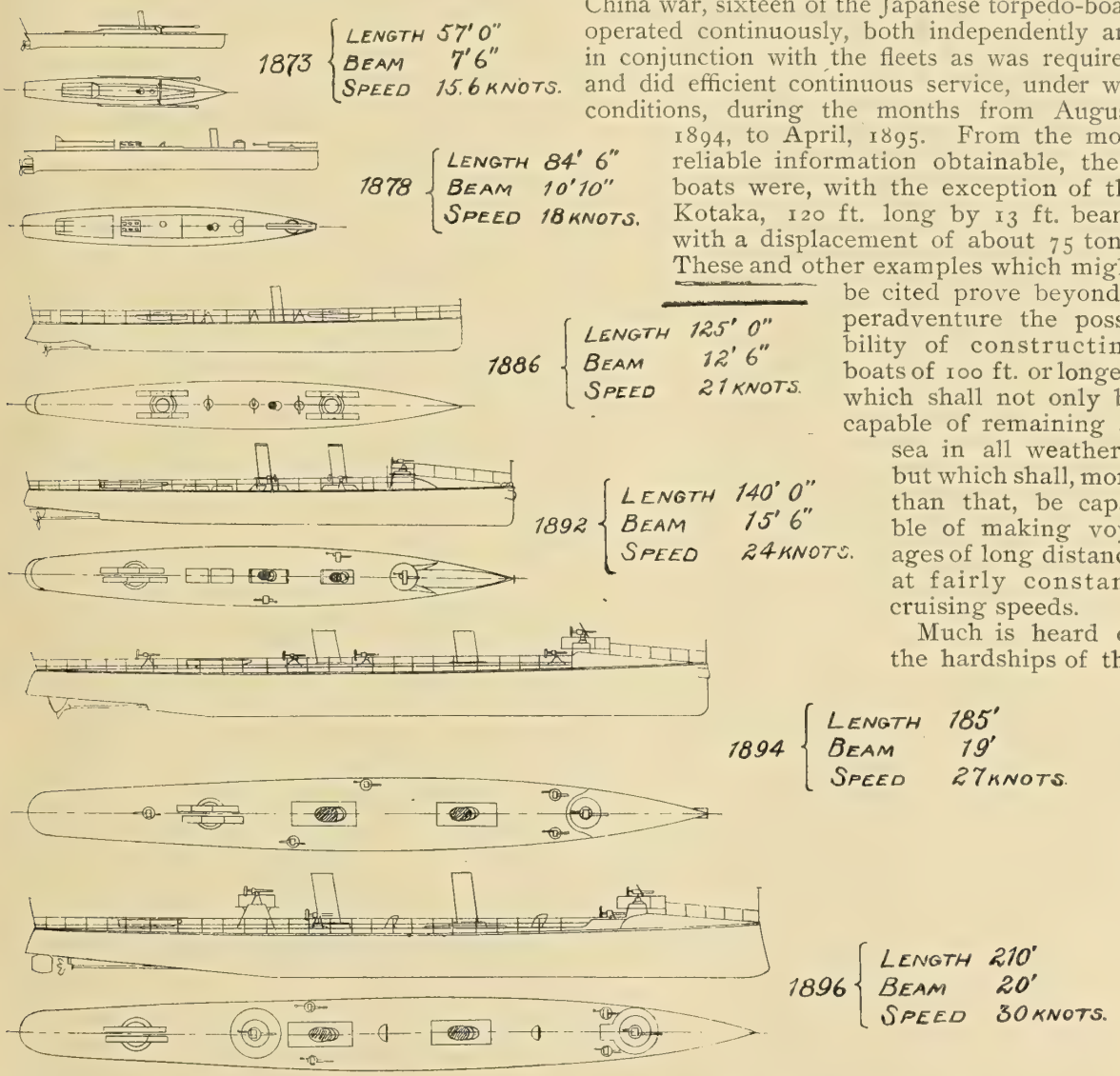
Name	Date.	Nation.	Length.	Beam.	Draught.	Displacement.	Armament.	Torpedo Tubes.	Designed speed.	Trial speed	Designed I. H. P.	Trial I. H. P.	Weight of hull.	Weight of propelling machinery.	Trial load.	Bunker capacity.	Economical radius.	Diameter of Cylinders. H. P.	Diameter of Cylinders. I. P.	Diameter of Cylinders. L. P.	Stroke.	Revolutions	No. boilers.	Kind of boilers.	Grate surface, each boiler.	Heating surface.	Boiler pressure.	Weight of engines, condenser, &c.	Weight of boiler, water and fittings.	No. of screws.	No. of blades.	Pitch.	Diameter.	Blade area.	Slip per cent.	Coal per I. H. P. per hour.	Turn speed	Remarks	Builders.
						Tons.			Knots.	Knots.			Tons.	Tons.	Tons.	Tons.									Sq. ft.	Sq. ft.	Lbs.	Tons.	Tons.									
Aluminum (second class)	1894	France	60′	9′ 3″		9.5				20.55		300	2	4.5	3			Compound.				591	1	Yarrow		500	185	1.5	3.0	1							Material used aluminum alloy of 14 tons per sq. in. tensile.	Yarrow & Co.
No. 126 No. 127 No. 128	1890	France	118′	13′ 1½″	3′ 9½″	69.98	2 1-pdrs,	2 18-in.	20	20.975	900	1025	26.68	29.32	14.0	10		17″.3		27″.24	17″.3	350	1	Locomotive	17.0	1387	142.2	13.64	15.68	1						1.907 at 20 knots. 1.25 at 10 knots.	1010		Normand.
No. 149	1892	France	118′	13′ 1½″	3′ 10″	74.55	2 1-pdrs.	2 18-in.	23	24.51		1333.5	28.85	27.23	18.47	14 petr'm		16″	23″	31½″	18″	340	1	Normand	35.5	1895	170.6	14.92	12.31	1	3	7′.77	6′.66				1020		Normand.
Sunderland	1890		137′	13′ 9″	4′ 0″	84				21.03		1203				13.8		15″	22″	33½″	18″	352	1	Locomotive		2173.5	155			1				26.6		1056	Burns liquid fuel	Doxford & Sons.
Aquilon	1895	France	137′ 8	14′ 76	4′ 43	118 1	2 47 mm	2		25 5 14 0		1973 1677 345		50 2		15½													2								Normand.
Ariel	1895	France	137′ 8″	14′ 39	Hull amid 4′ 43 Hull amid	118.84	2 3-pdrs.	1 bow 1 deck 1 bow		25.87		3682 est.	38.78	50.14	29.92 coal			15″.35	20″.47	29″.76	16″.3		2	Normand	33.35	1539	170	27.41	22.73	2		7′.9	5′ 66″					Rudder forward screws	Normand.
Flibustier	1894	France	137′ 8	14′ 39	4 53	123 34	2 47 mm.	1 deck 1 bow		25 66		2466		51.	17								2	Normand	31 35	1539				2								Doxford & Sons.
Lancier	1893	France	137′ 8″	14′ 39		117.88	2 3-pdrs.	1 deck		25.79		2367	39.85	47.85	30.18			15″.35	20″.47	29″.76	16″.3		2	Du Temple	40.69	1403	170	27.77	20.08	2		7′.9	5′ 66″					Rudder abaft screws	Normand.
Eclair Orage Kabyle	1892	France	143′	14′.7	Aft 8.23	104	2 1-pdrs.	1 bow 1 deck	20.5	21.5 21.7 21.6		1200				14.5	2165	17″.3	25″.2	39″.3	16″.5	317 315 317	2	Thornycroft	29 8	1825	185		19.86	1						872		Forges et Chantier de la Mediterranée, La Seyne.
Chevalier	1894	France	144′ 3″	14′.4		111.53	2 1-pdrs.	2 18-in.		27.22	2700	2959	42.02	51.01	18.5	17	5200					360.6	2	Du Temple	43	1642	213	19.68		2		9′.05	5′.85			At full speed 1.99 At full speed 1.51			Normand.
Forban	1894	France	144′ 3″	14′ 5″		124.8	2 1-pdrs.	on deck 2 14-in. on deck	30	31.03	3250	3945.2	45.39	62.67	16.74	15	2360	16″.14	22″.83	33″.07	18″.11	365	2	Normand	44.11	1035	213.3	36.33	26.34	2	3	10′.00	5′.9				1100		Normand.
No. 91 No 92	1894	England	142′ 6″	15′.5		129	3 3-pdrs.	3 18-in.	23	23.71 24.52		2600				24		19″	27″	27″	16″	380	2	Thornycroft		220				1		8′ 9″	6′ 2″	13.5				1013		Thornycroft.
Viper	1895	Austria	147′ 6″	14′ 9″		120	3 3-pdrs.	2 18-in.	24	26.64		2000				26	30	18″	24″	36″	18″	379.9	2	Yarrow	35	1868	174		18	1							1140		Yarrow.
Natter	1896	Austria	150 5	17 38	8 79	151	2 3-pdrs	1 18-in	23 5	26 5		2260				25 2	29 5						2	Thornycroft						1						1066	Has auxiliary bow rudder	Schichau.
Injeniero Hyatt Five First Class	1896	Chili	152′.5	15′.25	3 4½″		3 1-pdrs.	2 18-in. 1 bow	25.5	26.797	2000				27 25	40	2500 at 10 knots	18″	26″	39″	18″	355.4 373	2	Yarrow			175		18	1		7 6″				1119	Four are to be bolted up at works, then taken apart and shipped to Chili by steamer.	Yarrow.
Mousquetaire	1893	France	154′	15′ 7″	7′ 0″	125	2 1-pdrs.	1 deck	24.5	24.77	2100				18	2700		15″.8	23″.6	35″.5	15″.8		2	Thornycroft	41.2				32	2	3	8′.503	5′.512						Forges et Chantier de la Mediterranée Le Havre.
(Unnamed)	1896	Italy	154′.2	16′.92	3′.95	133			25			2466																										Odero.
Havoc	1893	England	180′	18′ 6″		215	3 6-pdrs.	1 12-pdr. 2 deck	26	26.78		3500				35	60	3500	18″	26″	39½″	18″	362	2	Locomotive	50	2500	165		54 5.35 each boiler	2	3	8′.0	6′ 6″	Developed 1700	9		1086	At 10 knots burns 3½ cwt. per hour.	Yarrow.
Hornet	1894	England	180′	18′ 6″		204	3 6-pdrs.	1 12-pdr. 2 bow	27	27.03		4000				35	60		18″	26″	39½″	18″	395	8	Yarrow	20.6	1027	172		43	2	3	8′.0	6′ 6″	Developed 1700	11		1185	Identical with Havoc, except for boilers.	Yarrow.
Decoy Daring	1893	England	185′	19″	6′ 25 6.28	240	3 6-pdrs 3 12-pdr. 4 6-pdrs.	1 bow 2 deck	27	27.76 27.79	3500	4049 4409		115	35			19″	27″	27″ 27″	16″	364 379	3	Thornycroft	63	2630	198 200	66.5	48.5	2	3	8′ 9″	6′ 2″	13.5	15		971 1011		Thornycroft.
Sokol	1895	Russia	190′	18.5	7′	240	3 6-pdrs.	2 16-in.	29	29.76	4000	3700				30	60		18″	26″	39½″	18″	405	8	Yarrow												1215		Yarrow.
Starfish	1895	England	190′	19′ 0″	5′ 7″	252	3 6-pdrs.	1 12-pdr. 1 bow 2 deck	27	28.0		4510		104 75	30	70	At 13 knots 2800		18″	27′	42″	18′	407	4	Blechynden	42.5		200								2.5 at 28.0 1.635 at 13 knots.	1221		Naval Construction and Armament Co.
Entre Rios Missiones Corrientes Santa Fé	1895	Argentine Republic	190′ 8″	19′ 6″	5′	250	1 14-pdr. 3 6-pdrs. 2 Maxim.	1 bow 2 deck	26	26.80 26.71 26.70		4000				35	80		18″	26″	39½″	18″	365 147 355					40.5	2	3	8′.0	7′.0				1095 1085	Sides and deck over machinery and boilers are of ¼″ steel.	Yarrow.
Handy Hart Hunter Lynx Ferret	1894	England	194	19′ 4½	6 35	225	1 12-pdr. 5 6-pdrs.	1 bow 2 deck	27	27.006 27 07 27.14		4451 4143 4315			31			18½	27½	32	18	390	3	Thornycroft	63	3163				2						1170	Hart reported to be fitted with Holden system of burning petroleum.	Fairfield Shipbuilding & Engineering Co.
	1894	England	194′	19′ 3″	5′ 5″	220	1 12-pdr. 5 6-pdrs. 1 12-pdr.	2 18-in. deck.	27	27.15 27.61		4507		123.61	30	70		19″	29″	43″	18″	363	4	Normand			175	59.4	64.2	2						1089		Laird.
Haughty Janus Lightning Porcupine Spitfire	1895	England	196′	19′	5′	231	5 6-pdrs.		27	27 5 27.31		3221 3789										363 4 397.1		Yarrow			193 192 197	49.0	70.69	2				2.54 at full speed		1101 1093 1085		Doxford & Sons. Palmer's Shipbuilding & Iron Co.
Swordfish Salmon Snapper Opossum Ranger Sunfish Conflict Wizard Teaser Zebra	1896	England	200′	19′	5′ 2½″ 7 5	265 Load 253 279 278 282	1 12-pdr. 5 6-pdrs. 1 12-pdr. 5 6-pdrs. 1 12-pdr. 5 6-pdrs.	2 deck	27	27.461 27.12 27.161 27.56 27.131 27.172 27.581	4000	4506 4570 3575 3609 3695 4055 4174		125	30			18½	27½	28″ 28″	18″	398 399 355 343 348 351	8	Yarrow	22½ 31	1063 1063	195 203 177 192 194 188	53.9	50.9	2 2 3	3 3	9	7	13.0		1.97 at 13 knots. 1.8 at 13 knots.	1194 1197 1065 1029 1044 1053	Boilers 41.2 tons ex. water	Armstrong, Mitchell & Co. Earle Ship & Engine Co. R. & W. Hawthorn.
Wizard Teaser Zebra	1896	England	200′	20′	6′ 0″	303	1 12-pdr. 5 6-pdrs.	2 deck	27		4500				30			19½	28½	30½ 30½	18″		3	White	70	3750	225									1188		Thames Iron Works.
Rocket Surly Shark Ardent Boxer Bruiser Desperate Fame Foam Mallard Quail Sparrowhawk Thrasher Virago Star	1895	England	200′	19′.5	5′.25	235	1 12-pdr. 5 6-pdrs.	2 deck	27	27.4 27.6 28.05 27.84 29.08 28.14 30.112 30.155 30.093 30.56 30 17 30 05		4200 4250 4175 4306 4487 4156 5620 5804 5657 6057 6425			30			18½	26½	40½	18″	396 401 405 396 410 374 398 394 392 365 363	4	Normand	41	2150	188 184 209 205 214 208	61.49	66.45 68.6	2 2				1.53 at 13 knots. 2.43 at 30 knots. 2.64 at full 1.64 at low speed	1188 1203 1215 1073 1093 1000 1191 1182	1.67 lbs. per I. H. P. at low speed.	Thornycroft. Thornycroft. Laird.
Whiting Chanos Cano	1896	England	220′ 2	20′ 20½		319 300	1 12-pdr. 5 6-pdrs.	2 deck	30	30 167	5900	6231			35			18″	27″.5	42″	18″	393	4	Reed														Palmer's Shipbuilding & Iron Co.

classifications. The characteristics of the boats for the two purposes are essentially as different as are the characteristics of the sea-going battleship and the coast defense monitor.

The Sea-Going Torpedo-Boat.

It is imperative that the sea-going torpedo-boat shall be seaworthy—that is, capable of remaining safely at sea in all such weathers as may reasonably be anticipated. Since the size of the boat has so vital a bearing upon its efficiency, it is important to consider what limitations are placed upon size by the necessity of seaworthiness, in order that it may be determined whether the size of boat consistent with the other characeristics required is consistent with this demand. In 1879, the Russian torpedo-boat Batoum (length 100 ft., beam 12 ft. 6 in., displacement 50 tons), made the voyage from London to Nikolaief, a distance of 4,800 miles, with a crew of three officers and nine men, at an average speed of 11 knots. In the following year, four boats for the Argentine Republic, of the same length and slightly less displacement, made the voyage from Plymouth to Buenos Ayres, under sail, with little difficulty, one of the boats requiring 72 days for the passage. In 1890 the English boats No. 61 and No. 62 (length 125 ft., beam 13 ft., displacement 75 tons), convoyed by the storeship Tyne, made, under their own steam, the voyage from Plymouth across the North Atlantic, encountering severe gales, fog and icebergs. Since that time boats of about the same size have been sent by the English naval authorities under their own steam from England to their naval stations in Australia, Hong Kong, Singapore, India, and the Mediterranean. Boats for Japan, China, and South American states have made the voyages from the European yards at which they were built to the ports of the countries to which they belong. During the Japan-China war, sixteen of the Japanese torpedo-boats operated continuously, both independently and in conjunction with the fleets as was required, and did efficient continuous service, under war conditions, during the months from August, 1894, to April, 1895. From the most reliable information obtainable, these boats were, with the exception of the Kotaka, 120 ft. long by 13 ft. beam, with a displacement of about 75 tons. These and other examples which might be cited prove beyond a peradventure the possibility of constructing boats of 100 ft. or longer, which shall not only be capable of remaining at sea in all weathers, but which shall, more than that, be capable of making voyages of long distance at fairly constant cruising speeds.

Much is heard of the hardships of the


1873 LENGTH 57' 0" BEAM 7' 6" SPEED 15.6 KNOTS.
1878 LENGTH 84' 6" BEAM 10' 10" SPEED 18 KNOTS.
1886 LENGTH 125' 0" BEAM 12' 6" SPEED 21 KNOTS.
1892 LENGTH 140' 0" BEAM 15' 6" SPEED 24 KNOTS.
1894 LENGTH 185' BEAM 19' SPEED 27 KNOTS.
1896 LENGTH 210' BEAM 20' SPEED 30 KNOTS.

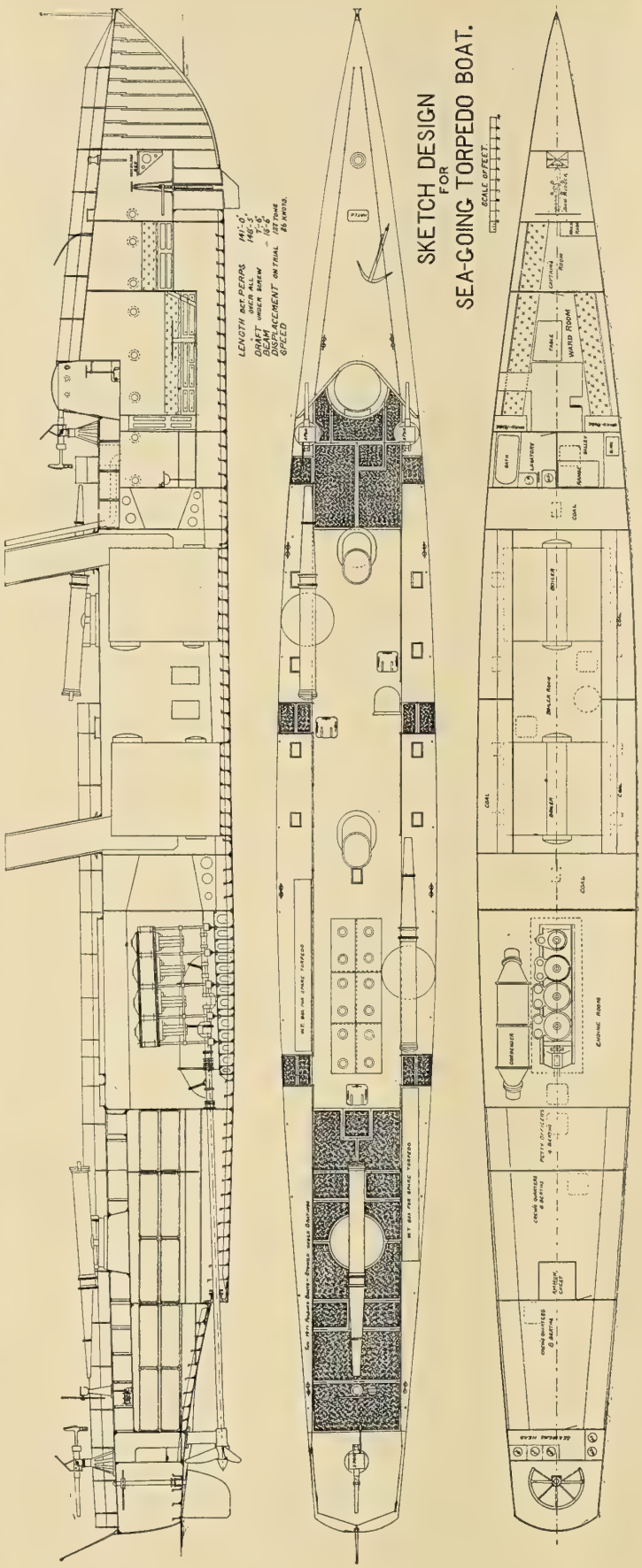
SKETCHES SHOWING GROWTH, IN SIZE AND SPEED, OF THE TORPEDO BOAT.

crews of sea-going torpedo-boats and of the impossibility of their long sustaining the fatigue, etc., of the life. The remedy for this must lie in special training of men for this service. The state of Massachusetts alone sends out more than 40,000 men who spend a large portion of each year at sea in fishing vessels, the average displacement of which is less than 50 tons, whaling vessels and steam trawlers being included in making up the average. No one who has seen the usual fishing vessel and who knows the provisions made for the crew of a torpedo boat can say that, for men habituated to life at sea in a small vessel, the lot of the torpedo boat crew is less happy than that of the crew of the deep-sea fishing vessel.

The size of the sea-going torpedo-boat may then be fixed by the considerations as to the qualities which it is desirable to embody in its design, with the certainty that, due regard being had for stability, it may be made seaworthy and habitable so long as the vessel determined by these considerations is not less than 100 ft. in length and 50 tons displacement. The sea-going torpedo-boat must be prepared to perform two kinds of duty. It must be capable of making a torpedo attack upon the ships of the enemy, and must be prepared to stand guard over and protect from torpedo-boat attack the ships of its own side. To fill both these roles, it is necessary that it should possess the following features: (1) An efficient torpedo armament. (2) A gun armament sufficiently powerful for an attack upon other torpedo-boats. (3) High speed. (4) Sufficient coal capacity. (5) Good manœuvring qualities.

TORPEDO ARMAMENT.

Torpedo experts are agreed that the long, 18 in. torpedo is the most desirable for this purpose. There remains to be considered the number of tubes which should be installed. The bow tubes which were at one time generally fitted have been abandoned on account of the interference of the bow wave with the tube and on account of the higher-speed boats running down the torpedo before it could gather way after being fired. Upon English, German, Italian, Russian, and our own first-class boats three training tubes have generally been installed. The Austrian, French, and Spanish boats of the same class, the English torpedo-boat destroyer and the



German division-boat have but two each. There is very little experience upon which to base conclusions as to the necessary number of tubes. Provision for three torpedo tubes with a torpedo for each, and for carrying two additional torpedoes, is in conformity with the views of the greater number of the progressive maritime powers.

GUN ARMAMENT.

The boat requires to be provided with an armament which will enable it to encounter and disable or turn back a boat attacking vessels over which guard is being kept. The 1-pounder gun has been shown to be incapable of stopping a torpedo-boat. The 3-pounder, possessing greater penetration and mining power, will. The guns and the torpedoes will not generally be used at the same time. It is believed that three 3-pounder guns would make a battery which could be manned by the crew of the torpedo-boat, and which would be sufficiently powerful for its purpose.

SPEED.

High speed is necessary in the sea-going torpedo-boat to make it meet three important conditions. The first is that it shall be in a class by itself, capable of refusing engagement with vessels of any other class than its own. The second requires that it shall be capable of approaching and getting away, in a torpedo attack upon ships, with sufficient rapidity to make the attack a success. The third condition is that when standing guard over ships to protect them from the attacks of torpedo-boats it shall be capable of pursuing and engaging these boats. The speed of the fastest cruisers of the world, attained only by a very limited number, is 22 knots, so that a speed in excess of this is required in the sea-going torpedo-boat in order to meet the first condition. The experience upon which to base the limit of speed required by the second condition is not great. The Almirante Lynch and the Almirante Condell attacked and torpedoed the Blanco Encalada without requiring the full 20 to 21 knots of which they were capable. The maximum speed of the Japanese torpedo-boats which operated very successfully during the Japan-China war was 23 knots, and upon two occasions these successfully attacked and torpedoed vessels of the enemy. There seems reason to believe that the speed fixed by the first condition is not too low to be consistent with the second. The third condition requires a consideration of the boats with which our sea-going boats may be expected to contend. Of the more than sixteen hundred serviceable torpedo-boats which are now possessed, are building, or are projected by the nations of the world, there are but 260 having a speed of more than 25 knots. Of these, 153 are of the large size and high speed known in the English service as torpedo-boat destroyers, and 87 more are credited with a speed of but 26 knots. It is believed, therefore, that a speed of 26 knots would be sufficient to make our sea-going torpedo-boat capable of performing any service which is within her province. To produce the power necessary for this speed a single vertical engine possesses several advantages which recommend it for the purpose. It will require a smaller number of men to run it and keep it in order. The first cost of the single engine is very much less than that of two engines for the same power. The economy of the larger unit is superior to that of the smaller. The single engine admits of a roomier and more commodious engine-room than would be possible with a pair of engines in the same space.

COAL CAPACITY.

Ideas vary widely as to the necessary coal capacity which should be given to a sea-going torpedo-boat. It is necessary that, when such boats are acting with a fleet, the embarrassment occasioned by the necessity of their procuring coal shall be reduced to the least possible, by giving them as large a capacity as practicable and making some of the times of requiring coal by the torpedo-boat coincide with the times at which the larger ships of the fleet must seek coal. The normal endurance of our battleships of least endurance is about 7,000 nautical miles. It is not practicable to obtain so great a radius as this in the sea-going torpedo-boat. It is, however, possible to provide in the design of these boats for sufficient coal to steam 3,500 to 4,000 nautical miles at 10 knots. The sea-going torpedo-boat would then require coal with the battleships of least endurance and once in each interval between the coaling of these ships. In connection with this matter of coal capacity, the possibility of torpedo-boats receiving coal at sea from ships should be noted. In the voyage of the English torpedo-boats No. 61 and No. 62, previously mentioned, they received coal as they required it from the storeship Tyne, which accompanied them, the coaling being performed without great difficulty, even during some of the very rough weather which was encountered.

MANŒUVRING QUALITIES.

The service required of the torpedo-boat demands that it should be capable of manœuvring readily in a small space. To offset the disadvantage in this regard which is brought in by the single screw proposed, the fitting of a bow rudder in addition to the usual stern rudder and for use in conjunction with it is suggested. This arrangement has been in satisfactory use upon boats constructed by Normand and Schichau for some years, and has proved satisfactory and productive of considerable improvement over the manœuvring qualities of boats fitted with after rudders only.

A boat embodying the features which have been enumerated would, under the customary trial conditions, with a load of 25 tons, representing the equipment, stores, coal, etc., on board, displace about 120 tons. Sketch plans of a de-

sign for such a boat are given on Page 8. The principal dimensions are:

Length on the water line	141 ft., 0 in.
Length over all	148 ft., 5 in.
Maximum beam	15 ft., 6 in.
Draught under screw	7 ft., 6 in.
Displacement (trial)	127 tons.
Speed	26 knots.

MACHINERY.

A single four-cylinder triple expansion engine:	
Cylinders 20 in. x 29 in. by 30 in. and 30 in.	
Stroke	18 in.
Revolutions, not more than	400
Indicated horse-power	2,700
Two water-tube boilers:	
Grate area, combined	110 sq. ft.
Coal capacity	40 tons.

Such a torpedo-boat could be constructed under the present industrial conditions for less than $100,000, so that at least two could be built for the cost of each of the largest of the boats which are now under construction for the Navy. In the design outlined in the sketch plans, the reserve of buoyancy is somewhat less than is commonly provided, although still more than 100 per cent of the displacement of the boat fully loaded. Provision is made for performing all the external service of the boat upon a platform which is raised some distance above the deck, so that although the reserve of buoyancy and freeboard are slightly less, the height of the deck upon which service is performed is more than is commonly provided in sea-going torpedo-boats.

Harbor or Coast Defense Torpedo-Boat.

Our three thousand miles and more of seacoast, with its miles upon miles of inlets and shallow channels, innumerable small outlying islands, and its many harbors, great and small, at once require the protection and afford unequaled opportunities for the use of coast or harbor defense torpedo-boats. While France has available for this kind of duty one torpedo-boat for every 9 miles of coast line, Russia one for every 10 miles, and Great Britain one for every 17 miles, we, who may at any time be called upon to defend our coasts from the attacks of battleships and cruisers of an enemy, have not a single torpedo-boat specially constructed for this purpose, although there are under construction several which are applicable to it. Of the value, as a means of defense, of a large number of small torpedo-vessels attached to and operating from coast stations as bases, there can be no question. They would attack ships of the enemy approaching the coast, and by their numbers and activity make anchorages on the coast absolutely untenable. Ready refuge in the shallow water of the many inlets or behind outlying islands or points of land would be always open to them.

Boats of this kind require: (1.) An efficient torpedo equipment. (2.) A light gun armament. (3.) The least possible draught. (4.) Good speed in deep and shallow water. (5.) Good manœuvring qualities.

TORPEDO EQUIPMENT.

It is not probable that more than one torpedo attack will be engaged in by this class of boat in each interval during which it is absent from its temporary or permanent base. During the Japan-China war in an attack of Japanese torpedo-boats upon vessels in the harbor of Weihaiwai, which resulted in the sinking of the Ting Yuen, seven participating boats fired eleven torpedoes. In a later attack upon the ships in the same harbor, which resulted in the sinking of the Lai Yuen, the Wai Yuen, and the tender Paufah, four participating boats fired seven torpedoes. There is reason to believe that provision for two torpedo tubes for the long 18 in. torpedo, with one torpedo for each tube, should be sufficient for these boats.

GUN ARMAMENT.

To provide the boat with means of embarrassing and keeping down the fire of an opponent when detached and chased by boats guarding ships which it is attacking, provision must be made for an armament which may be manned by the crews of the torpedo-tubes, and which is capable of a rapid and fairly accurate fire. The machine gun seems to be the best arm for the purpose. A battery of three of these manned by the crews of the torpedo-tubes should be effective.

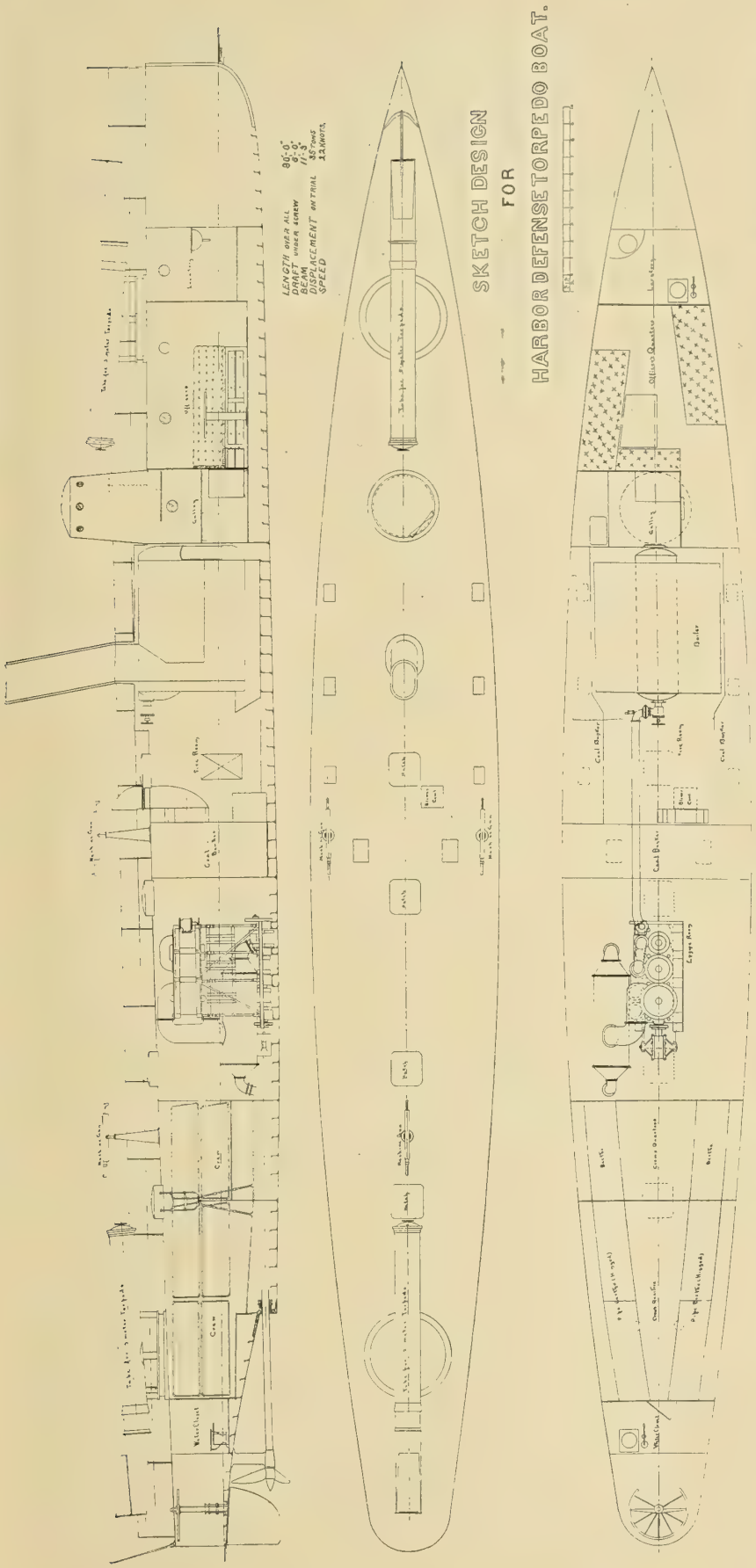
DRAUGHT.

Boats of this class must depend to some extent for their safety upon their ability to elude chasing torpedo-boats and destroyers by running into shallow water. The draught should then be made as small as practicable. Since the change of trim occasioned by high speed in a small boat is accentuated in shallow water, it is necessary to provide for a form of stern which will reduce to a minimum this evil, and it may even be desirable to provide for some trim by the head in still water so that the maximum draught at full speed shall not be increased on account of this change of trim.

SPEED.

The first two of the conditions fixing the limit of speed in the case of the sea-going torpedo-boat (the necessity of being in a class by itself and the necessity for sufficient speed to ensure success in a torpedo attack), hold in the case of the coast or harbor-defense boat. A speed of 22 knots is believed to be consistent with these two requirements.

The operations of such boats as these are necessarily restricted to night or foggy weather, and all the time not occupied in attack is spent within easy reach of coal, which can be had at every port, large and small, along the coast. There is, therefore, not the necessity for large steaming radius which exists in the case of the sea-going torpedo-boat, but full speed may be expected to be more commonly employed than in the case of the sea-going boats. Coal to steam fifteen hours at full speed should provide the means of striking quickly at a point some distance from the base and returning to the base after the attack.



A boat embodying the features here enumerated could be constructed to displace, under trial conditions, with a load of 10 tons representing ordnance, equipment, crew, coal, etc., on board, about 35 tons. Sketch plans of a design for such a boat are given on this page.

The principal dimensions are:

Length on water-line	90 ft., 0 in.
Maximum beam	11 ft., 3 in.
Draught under screw	5 ft., 0 in.
Displacement, trial	35 tons.
Speed	22 knots.

MACHINERY.

A single triple expansion engine:

Cylinders, 8 in. x 13 in. by 21 in.	
Stroke	15 in.
Revolutions	425
Indicated horse-power	650
One water-tube boiler:	
Grate area	30 sq. ft.
Coal capacity	11 tons.

Under the present industrial conditions such a boat could be built for from $25,000 to $30,000, so that a great number of them could be built at comparatively small cost.

In the preparation of a design for vessels of this class too great attention cannot be given to simplicity and adaptability of the weapon to the character of the men that will be available for duty with it in time of war. The coast or harbor defense torpedo-boat is a reasonable weapon to be placed in the hands of the Naval Reserve and of men who lay aside their peace-time occupations to defend the country.

The machinery in the sketch design is similar to, although more powerful than, that commonly found in small, high speed yachts, and men who are now serving in such yachts would, with a short training under an engineer officer of the Navy, be competent to take and run effeciently the machinery of these small torpedo-boats. The deck could, in part at least, be equally readily recruited from the men who in time of war lay aside peaceful occupations to take up the defense of their country.

RULES ADOPTED BY NAVY DEPARTMENT FOR RIVETING NAVAL VESSELS.

Instructions were recently issued from the office of Chief Constructor Philip Hichborn, of the Bureau of Construction and Repair of the Navy, for the purpose of standardizing the type of rivets used for naval vessels, together with general rules for spacing of rivets. These instructions will be followed under the direction of the Naval Director in charge, wherever work on naval vessels is in progress, except in such cases as the application of these rules would interfere with work already laid out.

Hitherto this important feature of construction has been left largely to the discretion of the builder, and the result has been a great lack of uniformity in the work on the various war vessels built under contract.

Rules for Riveting Naval Vessels.

All rivets are to be made from steel of the quality required by the official specifications of the Navy Department.

The various approved types of heads, points, etc., together with table of dimensions, for torpedo boat and ship work, are given on sheet No. 1, on the opposite page.

Rivet holes will be laid off in accordance with rules for sizes and spacing, given in Tables I, II, and III, which follow, together with such modifications, for special cases, as are noted.

All rivet holes through material 1 inch or more in thickness will be drilled, or if punched, will afterwards be reamed to finished size. The increase in diameter of hole due to reaming must be equal to at least one-eighth the thickness of the material. In punching, where possible, holes will be punched from the side which will form the faying surface.

Great care must be taken in punching to prevent holes from coming unfair. Any unfair hole must be reamed out before riveting, and a rivet suitable to the increased size of hole inserted.

Countersinking must be carefully done, following the rules for angle of countersink given on Sheet I. Holes for countersunk heads and points will be countersunk through the plate or shape to within 1-32 in. of the bottom, as nearly as may be in all cases, making it preferably a scant 1-32 in. in the case of thin plates and a full 1-32 in. for heavier plates.

The riveting is to be executed in a careful and workmanlike manner, especial care being taken that the rivets fit the holes accurately and are properly heated for driving, but not burned.

Rivets less than 3-8 in. in dia. will be driven cold. In torpedo boat work, rivets up to 7-16 in. inclusive, may be driven cold, at the discretion of the Superintending Naval Constructor. In this work care will be taken that no joints are riveted up until such precautions have been taken to insure a tight joint, as may have been directed by the Superintending Naval Constructor. Cold riveting is to be preferred for torpedo boat work.

The style of rivet used will be determined by the Superintending Naval Constructor. As a general rule, countersunk heads will be used only where required by mechanical or other special reasons. Wherever practicable, the pan-head rivet will be used, with countersunk points where flush work is required, button or snap points for finished appearance or where rivets are closed by power, and hammered or mashed points elsewhere. Where points are made with a snap tool, or where riveting by power is employed, care will be taken that the points are properly centered. In these cases, and also in the case of hammered points, the aim must be to have the point of adequate strength, following, as near as possible, the dimensions of points given on Sheet I. Care must be taken that snap points are not reduced from the standard sizes by grinding down tools that have been chipped or burred. All pan head rivets not less than 1-2 in. dia. for punched holes should be coned under head, as shown on Sheet I, the rule for punching from the faying surface of plate being carefully observed.

The Superintending Naval Constructor may require any holes to be drilled and bolts turned for them, or he may substitute bolts for rivets, as he considers necessary.

TABLE I.—DIAMETER OF RIVETS.

Weight of plates.	Diameter of corresponding rivets.	Diameter of corresponding rivet holes.
FOR TORPEDO WORK.	*Inches.*	*Inches.*
Up to 3 pounds, exclusive	¼	9/32
3 pounds to 6 pounds, exclusive	5/16	11/32
6 pounds to 7½ pounds, exclusive	3/8	7/16
7½ pounds to 9 pounds, exclusive	7/16	½
9 pounds to 11 pounds, exclusive	½	9/16
11 pounds to 13 pounds, exclusive	5/8	11/16
FOR SHIP WORK.		
Up to 3 pounds, exclusive	¼	9/32
3 pounds to 6 pounds, exclusive	5/16	7/16
6 pounds, inclusive, to 8 pounds, exclusive	½	9/16
8 pounds, inclusive, to 13 pounds, exclusive	5/8	11/16
13 pounds, inclusive, to 20 pounds, exclusive	¾	13/16
20 pounds, inclusive, to 30 pounds, exclusive	7/8	15/16
30 pounds, inclusive, to 40 pounds, exclusive	1	1 1/16
40 pounds, inclusive, to 51 pounds, exclusive	1 1/16	1 5/32
51 pounds, and above	1¼	1 11/32

In cases where rivets connect plates of different thicknesses together, the size of rivet indicated for the greater thickness, with corresponding spacing, will be used where strength is required, and that indicated for the lesser thickness where water tightness is a special consideration; always provided that the greater thickness is not more than double the lesser.

Where tap rivets must be used they will be 1-8 in. larger than the corresponding ordinary

STANDARD RIVETS.

SHEET 1

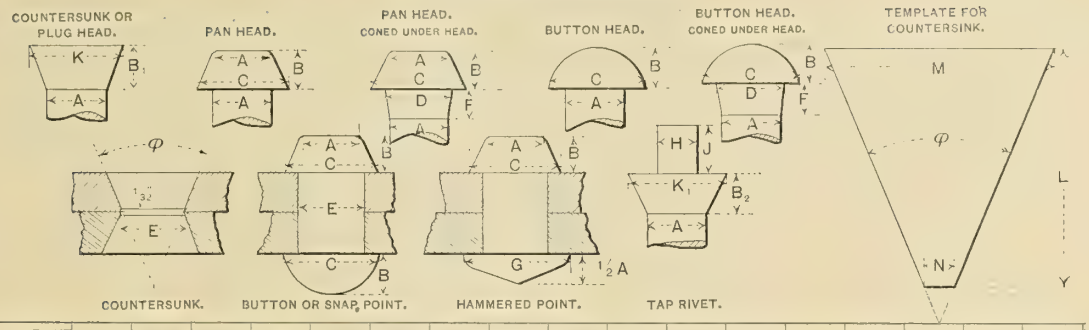
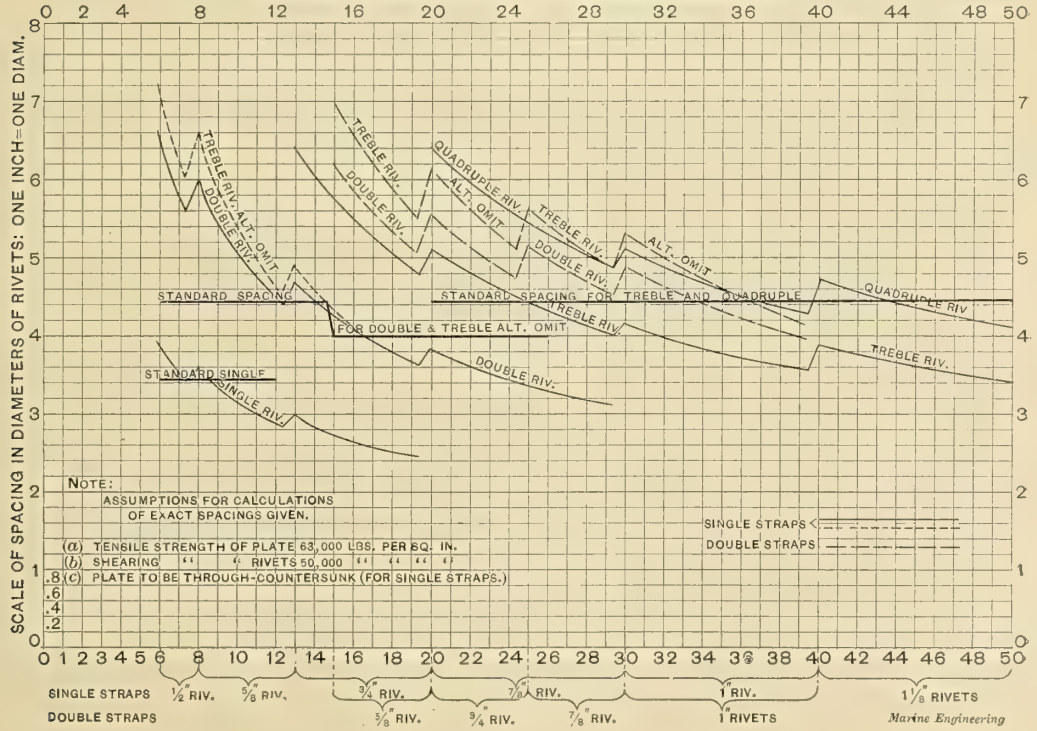


	PLATE WEIGHT LBS. PER SQ. FT.	A	B	B_1	B_2	C	D	E	F	G	H	K	K_1	J	φ	L	M	N
TORPEDO BOATS.	UP TO 3 LBS. EX	1/4"	3/16"	3/32"	—	7/16"	—	9/32"	—	1/2"	—	—	—	—	60°	2 1/2"	3 1/64"	1/8"
	3 " 6 "	5/16"	1/4"	3/16"	—	1/2"	—	11/32"	—	5/8"	—	—	—	—	60°	"	"	"
	6 " 7 1/2 "	3/8"	5/16"	7/32"	—	9/16"	—	7/16"	—	3/4"	—	—	—	—	60°	"	"	"
	7 1/2 " 9 "	7/16"	11/32"	1/4"	—	11/16"	—	1/2"	—	7/8"	—	—	—	—	60°	"	"	"
	9 " 11 "	1/2"	3/8"	5/16"	—	13/16"	—	9/16"	—	1"	—	—	—	—	60°	"	"	"
	11 " 13 "	5/8"	7/16"	3/8"	—	1"	—	11/16"	—	1 1/8"	—	—	—	—	60°	"	"	"
SHIP WORK.	UP TO 3 LBS. EX.	1/4"	3/16"	3/32"	—	7/16"	—	9/32"	—	1/2"	—	—	—	—	53°	2 1/2"	2 5/64"	1/8"
	3 LBS. " 6 LBS. "	3/8"	5/16"	3/16"	—	5/8"	—	7/16"	—	3/4"	—	—	—	—	53°	"	"	"
	6 " 8 "	1/2"	3/8"	1/4"	—	13/16"	9/16"	9/16"	1/4"	15/16"	—	3/4"	—	—	53°	"	"	"
	8 " 13 "	5/8"	7/16"	3/8"	—	1"	11/16"	11/16"	5/16"	1 1/8"	—	1"	—	—	53°	"	"	"
	13 " 20 "	3/4"	1/2"	9/16"	1/2"	1 3/16"	13/16"	13/16"	3/8"	1 5/16"	1/2" SQ.	1 3/16"	1 1/4"	5/8"	45°	3"	2 7/8"	3/8"
	20 " 30 "	7/8"	9/16"	3/4"	9/16"	1 5/16"	15/16"	15/16"	7/16"	1 1/2"	9/16" "	1 3/8"	1 5/16"	23/32"	45°	"	"	"
	30 " 40 "	1"	5/8"	1"	5/8"	1 1/2"	1 1/16"	1 1/16"	1/2"	1 3/4"	5/8" "	1 5/8"	1 1/2"	23/32"	37°	"	2 1/2"	1/2"
	40 " 51 "	1 1/8"	1 1/16"	—	3/4"	1 5/8"	1 3/16"	1 7/32"	9/16"	1 15/16"	5/8" "	—	1 5/8"	23/32"	37°	"	"	"
	51 LBS. & OVER	1 1/4"	3/4"	—	7/8"	1 13/16"	1 5/16"	1 11/32"	5/8"	2 1/8"	1 1/16" "	—	1 3/4"	23/32"	37°	"	"	"
		ALL RIVETS	PAN & BUTTON HEADS SNAP POINTS	COUNTERSUNK HEADS	TAP RIVETS	PAN & BUTTON HEADS SNAP POINTS	CONED UNDER HEAD	DIAMETER OF HOLES	DEPTH OF CONE UNDER HEAD	HAMMERED POINTS	TAP RIVETS	COUNTERSUNK HEADS	TAP RIVETS	TAP RIVETS				

EXACT SPACING OF RIVETS FOR JOINTS OF MAXIMUM STRENGTH.

SCALE OF WEIGHT OF PLATE: 1/4 = ONE POUND PER SQ. FOOT.

SHEET 2


SCALE OF SPACING IN DIAMETERS OF RIVETS: ONE INCH = ONE DIAM.
STANDARD SPACING
FOR DOUBLE & TREBLE ALT. OMIT
STANDARD SPACING FOR TREBLE AND QUADRUPLE
STANDARD SINGLE
TREBLE RIV. ALT. OMIT
DOUBLE RIV.
QUADRUPLE RIV.
ALT. OMIT
TREBLE RIV.
NOTE:
ASSUMPTIONS FOR CALCULATIONS OF EXACT SPACINGS GIVEN.
(a) TENSILE STRENGTH OF PLATE 63,000 LBS. PER SQ. IN.
(b) SHEARING " " RIVETS 50,000 " " " "
(c) PLATE TO BE THROUGH-COUNTERSUNK (FOR SINGLE STRAPS.)
SINGLE STRAPS
DOUBLE STRAPS
SINGLE STRAPS 1/2" RIV. 5/8" RIV. 3/4" RIV. 7/8" RIV. 1" RIV. 1 1/8" RIVETS
DOUBLE STRAPS 5/8" RIV. 3/4" RIV. 7/8" RIV. 1" RIVETS
Marine Engineering

rivets for the same thickness, excepting taps into heavy forgings or castings, such as stem and stern post, which will be 1-4 in. larger. Where strength is required tap rivets must not penetrate less than 1 dia., and should penetrate 1 1-2 dia. when the thickness of metal will allow it.

TABLE II.—SPACING OF RIVETS.

Connection.	Number of diameters from center to center.
Single-riveted laps and straps	3½
Double-riveted laps and straps	4
Treble-riveted laps	4½
Treble-riveted straps with alternate rivets in third row omitted	4
Longitudinal seams of plating required to be water-tight	4½
Connections of transverse frames not water-tight to outside plating	8
Deck plating to beams, and in general where special strength is not required	8
Connections of floor plates, brackets, lightened intercostals, etc., to clips and angles	7
Connections of vertical keel angles where not water-tight, of angles and other stiffeners to bulkheads, of boiler and engine bearings, and foundations generally	6
Connections of inner-bottom plating to all nonwater-tight frames and longitudinals	5
Connections of angles of water-tight frames and longitudinals to all plating, and in general where water-tightness is required between plates and shapes	4½
Connections of armor-shelf angle to shelf and outside plating	4½
In special cases of intercostals, beam ends, etc., where strength is required in connections of limited extent, spacing to be as required by circumstances, except that the rivets in the same line should never be spaced less than	3

Where the spacing in the above table cannot be followed exactly, as will generally be the case, the aim will be to make the spacing a trifle closer, as necessary, in the case of heavier plating, and a trifle further apart, as necessary, in the case of lighter plating, the division between "lighter" and "heavier" plating coming at about 7 1-2 lb. plates for single riveting, at about 15 lb. plates for double riveting, and at about 25 lb. plates for treble riveting.

Where the above distinctions are considered too complicated for yard work, the general rule will be to space a trifle closer, in all cases, as necessary for equal spacing.

When strength is required in laps and butted connections of plating, with the spacing indicated, single riveting is suitable only for plating under 12 1-2 lb. and double riveting for plating under 25 lb. Where strength is to be specially considered for the spacing of rivets in rows, the curves of exact spacings given on Sheet II (see page 13), should be consulted, or independent calculations made. For maximum strength in connections of platings above 30 lb. it will generally be found that quadruple riveting is required.

Single butt straps and edge strips should be 1 1-4 times the thickness of plates connected.

TABLE III.—BREADTH OF LAPS AND STRAPS.

	Diameters.
Breadth of laps for single riveting	3½
Breadth of laps for double riveting	5¾
Breadth of laps for treble riveting	8¼
Breadth of treble-riveted butt laps in outside plating	9¼
Breadth of edge strip for single riveting	6½
Breadth of edge strip for double riveting	11½
Breadth of butt strap for double riveting	11½
Breadth of butt strap for treble riveting	16½

TABLE IV.—ALLOWANCE IN LENGTH OF RIVETS FOR POINTS.

Diameter of rivet	In. ¼	In. ⅜	In. ½	In. ⅝	In. ¾	In. ⅞	In. 1	Ins. 1⅛	Ins. 1¼
	Allowance for point, over 2 thicknesses connected.								
Type of point:	In.	In.	In.	In.	In.	In.	In.	In.	Ins.
Countersunk	5/16	3/8	1/2	5/8	3/4	3/4	7/8	1	1 1/16
Hammered	3/8	7/16	1/2	5/8	3/4	7/8	7/8	1	1 1/16
Button	----	----	1/2	5/8	3/4	7/8	7/8	----	----

The allowances given above apply only to rivets which fit the holes neatly, as hereinbefore described.

TABLE V.—REDUCTION OF DIAMETERS TO INCHES.

Diameter of rivet.	Number of diameters.																	
	1⅝	2½	3	3¼	3½	4	4½	5	5¾	6	7	8	8¼	9¼	11½	12½	16½	18½
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
¼ inch	3/8	5/8	3/4	13/16	7/8	1	1 1/8	1¼	1 7/16	1½	1¾	2	2 1/16	2 5/16	2⅞	3⅛	4⅛	4⅝
5/16 inch	½	¾	15/16	1	1 1/16	1¼	1⅜	1 9/16	1 13/16	1⅞	2 3/16	2½	2 9/16	2⅞	3 9/16	3⅞	5⅛	5¾
⅜ inch	5/8	15/16	1⅛	1 3/16	1 5/16	1½	1 11/16	1⅞	2⅛	2¼	2⅝	3	3 1/16	3 7/16	4 5/16	4 11/16	6 3/16	6 15/16
7/16 inch	11/16	1 1/16	1 5/16	1 7/16	1½	1¾	2	2 3/16	2½	2⅝	3 3/16	3½	3⅝	4 1/16	5	5 7/16	7 3/16	8 1/16
½ inch	13/16	1¼	1½	1⅝	1¾	2	2¼	2½	2⅞	3	3½	4	4⅛	4⅝	5¾	6¼	8¼	9¼
⅝ inch	1 3/16	1⅞	2¼	2 7/16	2⅝	3	3⅜	3¾	4 5/16	4½	5¼	6	6 3/16	6 15/16	8⅝	9⅜	12⅜	13⅞
¾ inch	1 5/16	2⅛	2⅝	2 13/16	3 1/16	3½	3 15/16	4⅞	5	5¼	6⅛	7	7 3/16	8 1/16	10 1/16	10 15/16	14 7/16	16 3/16
1 inch	1⅝	2½	3	3¼	3½	4	4½	5	5¾	6	7	8	8¼	9¼	11½	12½	16½	18½
1⅛ inches	1 13/16	2 13/16	3⅜	3⅝	3 15/16	4½	5 1/16	5⅝	6 7/16	6¾	7⅞	9	9¼	10⅜	12 15/16	14 1/16	18 9/16	20 13/16
1¼ inches	2	3⅛	3¾	4 1/16	4⅜	5	5⅝	6¼	7 3/16	7½	8¾	10	10 5/16	11 9/16	14⅜	15⅝	20⅝	23⅛
⅛ inch	1	1 1/16	1 1/16	2	2 1/16	2⅛	2 13/16	3⅛	3⅜	3¾	4⅛	5	5 1/16	5 13/16	7 3/16	7 13/16	10 5/16	11 9/16

Centers of rivets should be placed not less than 1 5-8 times the diameter from the edges. In double and treble riveting, the distance from center to center of rows should not be less than 2 1-2 diameters, and in butt laps of outside plating not less than 3 diameters.

Double butt straps should not be used for water tight work, owing to difficulty in calking. They may be used, however, to advantage in connections requiring great strength, but not water tightness. Where double butt straps are used, the size of rivet to be used will be as follows:

For plates from 15 to 20 lb., exclusive, 5/8 in. rivets.
For plates from 20 to 25 lb., inclusive, 3/4 in. rivets.
For plates above 25 lb., as per single riveted straps.

Centers of rivets should be 1 5-8 diameters from the edge and rows spaced 3 diameters from center to center.

Width of straps for double riveting, 12 4 diameters.
Width of straps for treble riveting, 18½ diameters.

Thickness of each strap to be 1-2 the thickness of plates connected for double riveted straps, and 5-8 the thickness for treble riveted straps.

Spacing of rivets in rows to be calculated, or taken from Sheet II (see page 13).

Special care will be taken in riveting that rivets used are of sufficient length to insure a proper point, the aim being to have the rivet a trifle long if anything. Such cutting as is necessary should be done while the rivet is still a dull red, and the point finished after further cooling. The allowances for length over the thicknesses connected are given in Table IV, the allowance being for two thicknesses only. An additional allowance of 1-16 in. is to be added to that given for each additional thickness connected, unless the additional thickness is less than 3-16 in., when 1-32 in. additional allowance will be made.

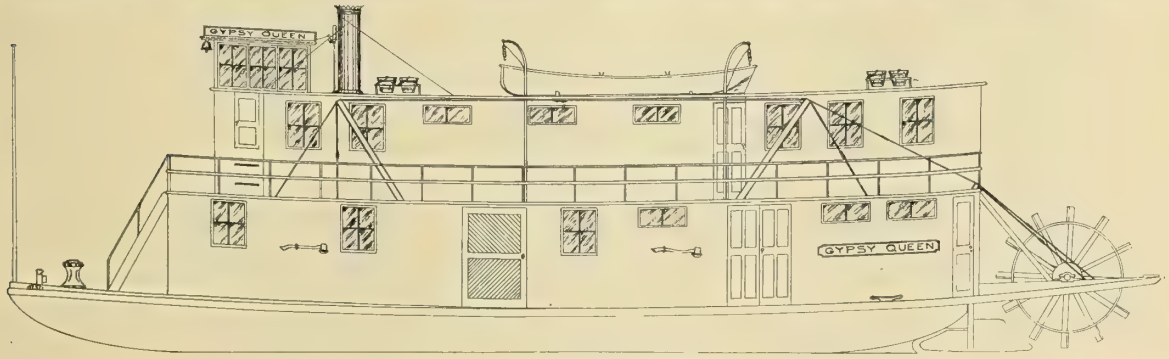
In all exceptional cases the spacing will be as directed by the Superintending Constructor. For special foundations, or where there is liability to excessive vibration or corrosion, the spacing as laid down in the foregoing rules will be departed from as he may deem advisable.

Table V is given for convenience in transposing a spacing or dimension, given in diameters, to its actual value in inches, to the nearest sixteenth covering all such values embodied in the foregoing rules.

River Boat Gypsy Queen for the "Klondike."

A typical river boat for the "Klondike" trade is shown in the sketch of the Gypsy Queen just completed by the Marine Iron Works of Chicago. This is a double cabin stern wheel boat with a wood hull, built in sections for convenient transportation to the Yukon gold fields. The principal dimensions are: Length on L. W. L., 60 ft.; beam on L. W. L., 16 ft.; width of guards, 2 ft.; width on deck, 20 ft.; length of lower cabin, 50 ft.; width of lower cabin, 16 ft.; upper cabin, 44 ft. by 12 ft.; pilot house, 6 ft. by 7 ft.; head room all through, 6 ft. 6 in. the clear; draft with 30 tons of load, 2 ft.

The hull is of white oak and Georgia pine, fastened almost entirely with bolts. To keep down weight even the boiler, which is of the water-tube type, is provided with a built up drum, the heaviest section of which weighs 400 pounds. In the machinery equipment, indeed, special care has been taken to have every part light and strong, having regard to the severity of the climate and the remoteness from any modernly equipped repair shop. Cast steel, bronze, and forgings have largely been used instead of cast iron. The paddle engines have cylinders 7 1-2 in. by 28 in. with balanced piston valves built for a steam pressure of 200 pounds per sq. in. The boiler has 19 sq. ft. grate surface and 600 sq. ft. heating surface. The stern wheel is 9 ft. dia. and 11 1-2 ft. wide, fitted with 12 buckets each 12 in. wide. It is counterbalanced to offset the weight of cranks and rods. There is also fitted an electric light plant, feeding fifty 16 C. P. incandescent lamps throughout the boat. The only fuel obtainable in the Yukon region at present is wood. Heretofore a plentiful supply of seasoned timber, which averaged 3,000 pounds to the cord, was obtainable, but this has been pretty much used up and next season green wood will probably have to be used, weighing 4,000 pounds to the cord. It is calculated that the Gypsy Queen when headed up stream will consume approximately four cords in 24 hours, and as she will average five miles an hour the consumption will be about one cord for thirty miles. Wood stoves are used for heating the cabins and there is also a hot water heating system as well as hot water supply in the bath room.



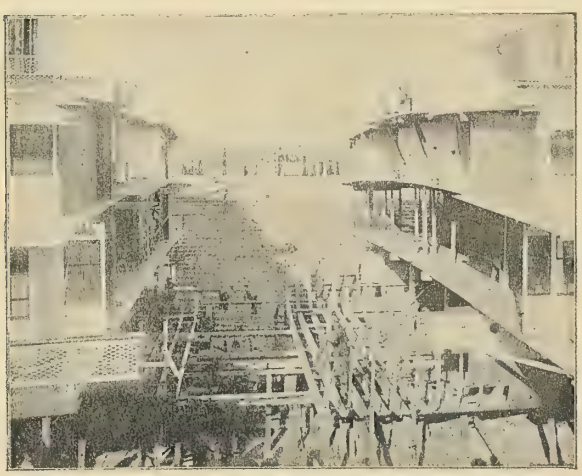
STERN WHEEL BOAT GYPSY QUEEN FOR YUKON RIVER.

Lengthening the River Steamer New York.

Lengthening a steamship by cutting it in two and building in additional frames and plating has become a very frequent operation in shipbuilding practice.

A clever example at home of this operation is shown in the accompanying engraving of the Hudson river steamer New York, which has been lengthened 30 ft. by the Erie Basin Dry Dock Co., in Brooklyn. The vessel is one of the famous Albany Day Line boats and in dimensions is 311 ft. long, 40 ft. beam molded, and 12 ft. 3 in. deep. Her normal draft is 6 ft. She is a side wheel vessel, with feathering floats, and is fitted with a 3,800 H. P. beam engine and three return flue boilers.

The incision was made just abaft the funnels and forward of the engine. The New York was floated into the dry dock and let down on the blocks in the usual way. Then a cradle was built beneath the forward portion of the hull, and this was carried on regular launching ways, except that they had no inclination. When this was ready, the rivets in the plating were cut out and the bow section drawn forward along the ways



ENDS DRAWN APART, SHOWING NEW FRAMES.

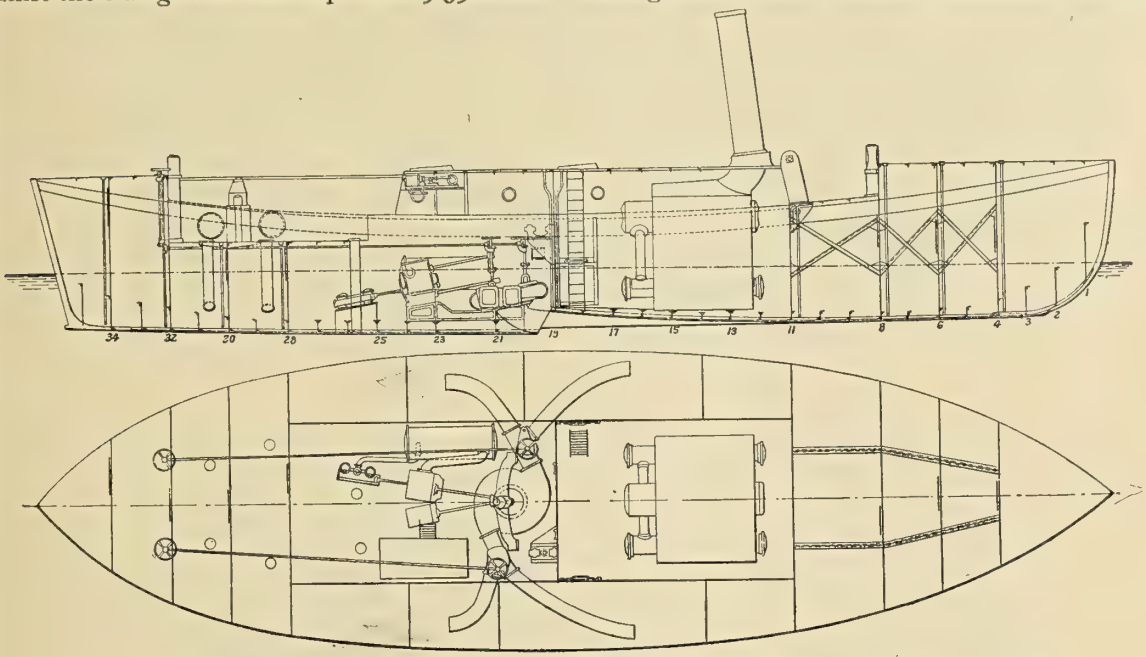
by tackle leading to steam winches in the yard, beyond the dock coping. The section moved weighed about 350 tons and was brought to its new position in five and a half minutes. When the two ends were lined up, the bow section had a vertical cant of 3-16 in. to port and there was a fore and aft twist of about 1 in. These were easily corrected and the work of raising the additional frames was rushed, so that within 17 1-2 hours from the time of docking the frames were up and ready for the platers. The addition to length brings the wheels considerably farther aft relative to the entire length of the boat. It is expected that her draft will be lightened several inches and a slight increase of speed will be possible with the same power. The arrangements were made under the supervision of W. D. Dickey, superintendent of the company. A similar operation was performed on her sister ship, the Albany, about five years ago.

Hydraulic Propelled Steam Lifeboat.

Hydraulic propulsion has been tried both in this country and in England, and has been abandoned because of its low efficiency as compared with screw propulsion. There are cases, however, in which the special advantages of the system more than offset the wastefulness, and one of these is the equipment of a steam lifeboat. A screw propeller, in the ordinary form, could not be used for fear of mishap by fouling ropes or wreckage, and again the violent motion of the boat in short steep seas would cause unmanageable racing. For these reasons the Royal National Lifeboat Institution of the British Isles when planning a steam lifeboat recently decided to build a hydraulic propelled boat. The contract was let to John I. Thornycroft & Co., the well-known English torpedo-boat builders, and they constructed the boat here illustrated. She was named the "Queen," and is now stationed at Liverpool on the Mersey. A boat of this type had previously been built for the Dutch institution and proved very successful. The photographic reproduction shows the "Queen" steaming on the river Thames on a trial trip from the builders' works. She is built of mild steel and her dimensions are: Length, over all, 55 ft.; on the water line, 53 ft.; breadths, molded, 13 ft. 6 in.; over sponsons, 15 ft.; and extreme, 16 ft.; depth molded, 5 ft. 6 in.; extreme water draught, when fully loaded, 3 ft. 3 in. The load consisted of crew, four tons of coal, mast and sails, and several passengers, and the tanks full of fresh water, which, with the propelling machinery and boiler give her a displacement of about 30 tons. The hull of the boat is divided into eighteen watertight compartments, two of which are occupied by the engines and boiler, and two forming the coal bunkers, each being capable of being freed of water—the smaller by a portable deck pump, and the larger by the main engines.

The propelling machinery consists of a compound surface condensing engine, with cylinders side by side and inclined, 8 1-2 in. and 14 1-2 in. dia., and 12 in. stroke. This drives direct a nearly horizontal centrifugal pump, the impeller of which, 30 in. dia., delivers the water with which the pump is fed, by a scoop-shaped inlet amidships, through four nozzles or outlets in the sides of the boat, two for motion ahead—one on either side—being placed below the water, aft, and those for motion astern close under the sponsons above water, forward. The engine has no reversing gear, but is always running one way, the direction of the boat ahead or astern being controlled by valves in the discharge pipes from the centrifugal pump. These controlling valves can be worked either from the engine room or by the coxswain at the steering wheel, and by moving one valve only the boat may be made to turn round on her center, and may consequently be steered independently of the rudder. The boiler is of the ordinary Thornycroft water-tube type,

situated in a separate closed compartment forward of the engines and with a fan for forced draft. The steam pressure is 140 lbs. per sq. in. maintained with an air pressure in the stokehold, on a trial run, equal to 2 3-8 in. of water. The power developed by the engines was 220 I. H. P. at 449 revolutions per minute. Runs with and against the tide gave a mean speed of 9.39 knots.

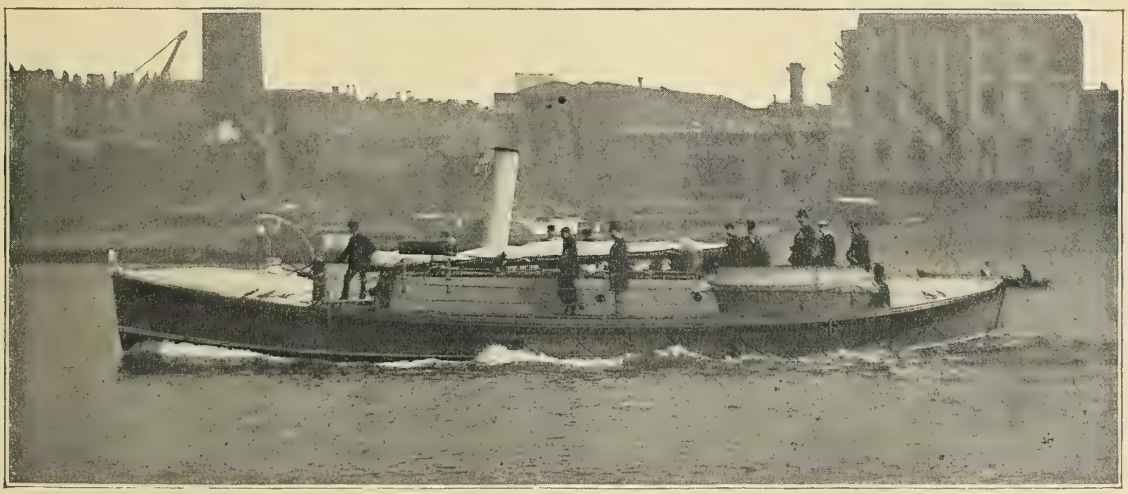


SKETCHES SHOWING LOCATION OF MACHINERY IN LIFEBOAT QUEEN.

Steering is effected by an ordinary deep rudder, which is moved by simple worm gearing and fitted with an arrangement for tricing it up in shoal water, without interfering with steering operations. For working the anchor and warping purposes a steam capstan, driven by an independent engine, is fitted at the after end of the engine-room, a reel of 100 fathoms of flexible steel wire rope being fixed in the cockpit or well of the boat. To assist the propelling power and the steadying of the boat it is fitted with a mast hinged in a tabernacle forward, and when not in use is lowered and stowed along the covering of the machinery. When in use it carries a lug sail and staysail.

The boat was placed on her station early last month after a rather severe test in the Mersey, during which Lord Charles Beresford, the Lord Mayor of Liverpool and other officials, remained on board. There was almost a gale blowing. The cost of this boat complete was $25,000, which was made up by donations from Liverpool merchants and marine organizations.

The general arrangement of the machinery is shown in the accompanying drawings, for which and the description of the boat we are indebted to the courtesy of Messrs. Thorp, Platt & Co., of New York, the builders' agents in America.



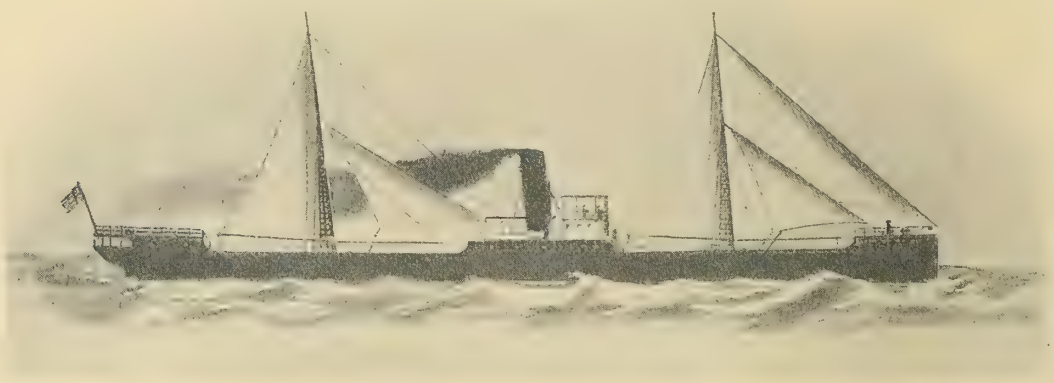
HYDRAULIC PROPELLED LIFEBOAT QUEEN STEAMING ON THE RIVER THAMES.

FIRST AMERICAN STEEL TRAMP STEAMSHIP NOW BUILDING AT BATH, ME.

At the Bath Iron Works, Bath, Me., a steel steamer is now under construction which will occupy a very prominent place in the history of American shipping. This is the first steel tramp ocean steamer which is American clear through, in design, material, workmanship and ownership. On November 30 the contract was closed by the builders with Messrs. Miller, Bull & Knowlton, of New York, for whom the steamer is building. She will likely be called the "Winifred," after the latter gentleman's youngest daughter.

The new steamer has been designed with very great care and much skill to compete with any vessel of her class, afloat or building, of any nation. Her principal dimensions are: Length over all, about 305 ft.; between perpendiculars, 290 ft.; beam, extreme molded, 42 ft.; beam at main deck, 41 ft. 6 in.; depth molded at lowest point of sheer in center of deck, 25 ft. 8 in.; depth molded at side, 24 ft. 10 in.; load draft, 18 ft. 9 in.; free board, 6 ft. 1 in. As will be seen from these figures, the "Winifred" has a large percentage of reserve buoyancy, and if the minimum freeboard is designated by Lloyds, she will probably be allowed to load beyond this load draft. A general idea of the appearance of the steamer as she will sit in the water can be had from the accompanying engraving. She will be built to conform to Lloyds highest class, and the hull will be especially heavy and strong. The proportions according to Lloyds rules are: Ratio of length to depth, 11.18 to 1; length to beam, 6.87 to 1, and beam to depth, 1.62 to 1. The vessel has a very full midship section, the deadrise being about 12 in. and her block co-efficient is about eight-tenths. She is handsomely modeled, and her entrance and run, for a boat of this fulness, are remarkably easy and fine. She will be very thoroughly subdivided, having six complete water-tight transverse bulkheads and two partial bulkheads.

As will be noticed in the engraving, the "Winifred" will have a forecastle, bridge-house amidships and high poop. The bulwarks connecting the ends will be about 3 ft. high and will form a forward and after well. In the forecastle there will be berths for eight firemen and eight sailors with mess room, wash room and toilet room. Here there will be also carpenter shop, lamp room, vegetable store and ice room. A Hyde steam windlass will be located on the forecastle deck. The midship house as designed will be solely for the accommodation of the ship's officers. The machinery casings run fore and aft in the center, with a Williamson steering engine at the forward end and a commodious storeroom at the after end of the bridge. On the port side the design shows six comfortable staterooms, with necessary baths and toilet rooms, for the accommodation of the Chief and Assistant Engineers, First and Second Mates, Quartermaster and oilers. On the starboard side a large mess room occupies the forward end of the bridge, abaft of which is the galley, pantry and cold storage rooms, and at the after end on this side, the room for the Steward and cooks. The passageways through the bridge-house, connecting the forward and after decks, are 4 ft. wide.



STEEL TRAMP STEAMSHIP WINIFRED AS SHE WILL APPEAR AT SEA.

The poop is designed for the use of the Captain and passengers, there being three large spare staterooms here, with toilet room, pantry and a spacious saloon or cabin.

On the bridge deck forward, the chart house is placed, with the top extending to the sides forming a navigating bridge.

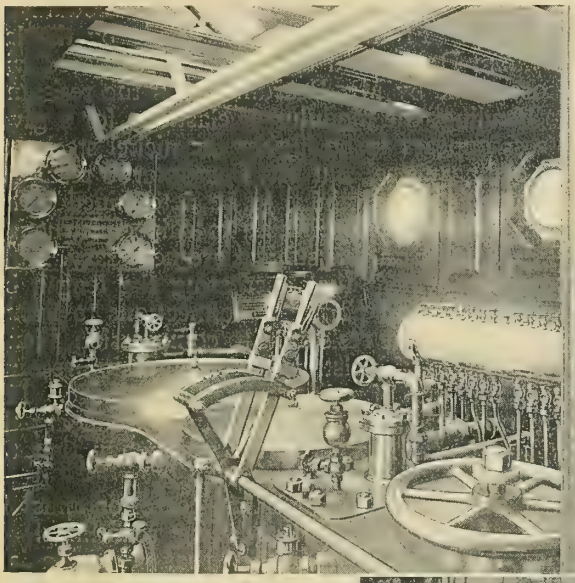
The steamer designs show a double bottom on the McIntyre system, the depth of the tank being 4 ft. This will contain about 700 tons of water ballast. The tank top is ceiled with 2 1-2 in. yellow pine. Yellow pine 3 1-2 in. thick is also used to cover the lower deck, and 2 in. thick for the forecastle, bridge and poop decks. The main deck is of steel throughout and is only covered with 2 1-2 in. yellow pine in the living spaces.

Arrangements for handling cargo are very carefully worked out. Large hatches are fitted, those on the main deck (of which there are four)

are each 26 ft. long and 14 ft. wide. On the lower deck they are the same length, but 2 ft. wider. The bulwarks are arranged to be hinged in the wake of the masts to facilitate loading and unloading. There are two pole masts, each mast

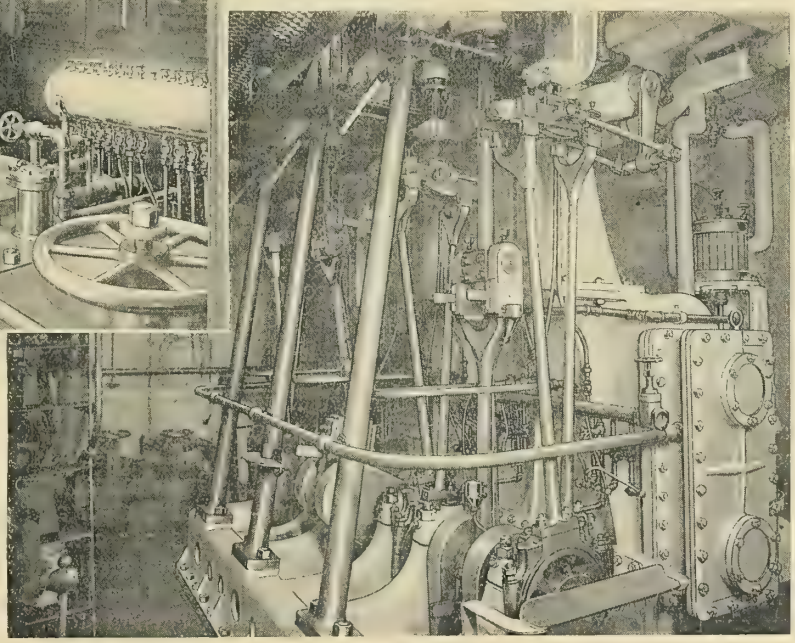
U. S. REVENUE STEAMER GOLDEN GATE, IN SAN FRANCISCO HARBOR.

to be fitted with four 40 ft. cargo booms and special chain stays for the rapid handling of light cargo. The vessel will be provided with leg of mutton sails, one of the cargo booms on each



mast being used as a boom for the foot of the sail when canvas is spread. Two large life boats and an 18 ft. gig will be carried on the bridge deck.

The machinery will consist of a triple-expansion engine of about 1,200 I. H. P., with cylinders 20 1-2 in., 34 in. and 55 in. dia. and 3 ft. stroke, run at about 95 revolutions. Steam will be furnished at a pressure of 165 pounds by two Scotch boilers, each 12 ft. 6 in. dia. and 12 ft. 3 in. long. The grate surface is 120 sq. ft. and heating surface about 4,000 sq. ft. A Scotch donkey boiler about 7 ft. 6 in. dia. will furnish steam for the windlass, steering engine, and four large cargo winches. Coal bunker capacity for 450 tons is provided in such a way that part of the bunkers will be available for cargo on short voyages. The "Winifred" will have capacity for about 178,000 cu. ft. of grain and about 170,000 cu. ft. of bales. It is estimated that she will carry about 3,700 tons dead weight on 18 ft. 9 in. draft at a speed of about 10 knots.



VIEWS IN ENGINE ROOM OF STEAMER GOLDEN GATE.

U. S. Revenue Steamer Golden Gate.

The Golden Gate was designed as a boarding-boat for use by the Custom House authorities in San Francisco Harbor, California, and was recently built complete by Moran Bros. Company, Seattle, Wash. The hull is constructed entirely of open-hearth steel, and the principal dimensions are: Length over all, exclusive of fenders, 110 ft.; length between perpendiculars, 100 ft.; breadth of beam moulded, 20 ft., 6 in.; depth moulded at mid-length, between perpendiculars, 12 1-2 ft.

The vessel is fitted with a main deck house constructed of steel and a pilot house on top, the interior finish being in native hard woods, maple and spruce. She is fitted with a Williamson steam steering engine. The vessel is propelled by a vertical engine of the triple expansion type, with H. P. cylinder 13 in. dia., I. P. cylinder 21 in. dia., and L. P. cylinder 32 1-4 in. dia., and a stroke of 24 in. The collective I. H. P. of the propelling, air pump, and circulating pump engines is 525 when the main engine is making 160 revolutions per minute. The condenser forms part of the main framing of the engine. The air and circulating pump is of the Blake vertical patent, and is attached to the condenser and operated independently from the main engine. The propeller is of manganese bronze, right-handed, true screw, with four blades 7 ft., 6 in. dia. and 10 ft., 6 in. pitch. The condenser is fitted with 592 seamless drawn brass tubes 5-8 in. O. D., No. 18, B. W. G., and they are 8 ft. 3 1-4 in. long. The vessel made on her trial run a speed of about 14 knots.

The boiler is of the Ward water-tube, with 77 sq. ft. grate surface and 2,970 sq. ft. heating surface. The boiler casing is 11 ft. 6 in. dia. and 8 ft. 3 in. high. There is bunker capacity for 50 tons, and the fresh water tanks hold 3,000 gallons.

ON NICKEL STEEL AND ALUMINIUM AS MATERIALS FOR SHIP CONSTRUCTION.*—II.

BY J. H, BILES, M.I.C.E.

In nickel steel of 52 tons ultimate and 28 tons elastic strength, as compared with ordinary steel of 28 tons ultimate and 14 tons elastic, a material is afforded which may be considered twice as strong as the mild steel at present in use. This would allow a reduction of one-half in scantlings which are determined wholly by tensional stresses if the butt connections can be made good. The unavoidably weakest section in the longitudinal plating of a ship is the line across the frames or beams, and where rivets in these lines are spaced eight diameters apart the strength is about seven-eighths (0.875) of the solid plate. Hence the question is: Can butt connections having 0.875 efficiency be developed? This is the highest possible strength of the plating. Taking the butt of only one plate into consideration, and neglecting the advantage of rivets in the landings between frame line and the butt, it is evident that if the back row has rivets spaced eight diameters apart, if sufficient rivet area be given, even if the rivet material is specifically only as strong as mild steel, if sufficient thickness of butt strap be given, we can make a riveted butt connection whose efficiency shall be 0.875. But the butt connection has not alone to be relied upon, as the adjacent passing strakes will give support to the butt. Hence there appears to be no great difficulty in developing sufficient rivet connection in the butts. It should be borne in mind that in passing from iron to mild steel the same difficulty had to be encountered. Iron rivets have as much strength per unit area as the plate. Steel rivets have not more than 80 per cent, nickel steel rivets have about 70 per cent. As to the landings or laps, there is not the same necessity for high efficiency. In the vicinity of the neutral axis, where the shearing stresses may be high, the same area of rivets as is now adopted will be more than sufficient.

As to the ratio of diameter of rivet to thickness of plate which the consideration of the bearing pressure imposes, it is easy to see that with 42 tons to 43 tons as limit of bearing pressure, and 22 tons as the effective ultimate resistance to shearing of rivets in groups, that the diameter of rivets should not exceed two and one-half times the thickness of plate. This is not in opposition to existing practice.

The question of resistance to compression is the vital one in adoption of nickel steel. The ultimate resistance to compression given by Mr. Beardmore in a specimen of 1.596 in. diameter and 10 in. long is 29.79 tons. But for thin plates the real resistance depends on the modulus of elasticity. From experiments made by the late William Denny and Mr. Martell, compared with those made by Mr. Beardmore, on the resistance to bending, the modulus of elasticity for a given stress appears to be higher for nickel steel than for ordinary steel, but Mr. Beardmore's results do not enable the modulus to be determined within limits which are applicable to ship construction. Experiments on this subject are necessary. It is, however, evident that decreasing the length between the fixed points or connections to frames will increase the resistance to compression. Hence the problem of resistance to compression resolves itself into one of reducing the frame space. This can only be done economically by reducing the weight of the frames in the proportion that the frame space is reduced.

It may be anticipated that corrosion must be taken into account in reducing scantlings. It may, however, be remarked that corrosion is a function of two things: (1) The specific resistance to corrosion of the material; and (2) the care that is taken of the material to protect it from corrosive action.

The first has been experimented upon by Mr. Beardmore, who gives the relative corrosion of nickel steel and mild steel as 1.36 per cent and 1.72 per cent, a gain of 21 per cent in favor of nickel steel. Mr. Riley gives the corrosion of nickel steel of 3 to 5 per cent of nickel, as one-half of carbon steel.

The second consideration can only be referred to experience. When a ship corrodes badly, it is due to neglect. It is possible to take sufficient care of ships that practically no corrosion takes place. Well cared for war ships have practically

* From a paper read before the Institution of Civil Engineers, London, 1896.

no corrosion. In torpedo boats with very thin scantlings, galvanizing and proper care avoid the results of corrosion. In a torpedo vessel built in 1885, which has recently been opened up for reboilering, it was found that the hull was practically as good as new. Hence any objection, on account of corrosion, to reducing scantlings may be discounted, by insisting upon proper precautions being taken in the care of the vessel.

The possibilities of adding resistance to compression are not exhausted by reducing frame space. Additional rigidity may be given to the plating by arranging its sectional area, so that the plates are narrower, and consequently have more landings or laps to stiffen the plating. Further, the edges of the plates may be stiffened by flanging them between the frames. The subject is one deserving of experiment.

Many local requirements of strength in a ship are determined by rigidity, and not ultimate strength; but in a great many of these there is unfortunately no precise method of procedure. In passing from iron to mild steel many of these cases followed the general rule of 20 per cent reduction, and no ill effects have followed. Mr. Martell, in his report in 1877, upon which the action of Lloyd's in reducing scantlings in ships built of mild steel was based, stated that a 5-16 in. steel plate would resist deflection as well as a 6-16 in. iron one. The difference in tensional strength between nickel steel and mild carbon steel is greater than that between mild steel and iron. Experiment could readily determine whether the stiffness of nickel steel is proportionately greater than that of mild steel.

The reduction of specific weight of material seems to be only possible by the adoption of aluminium. It seems doubtful whether any alloy of this metal of small specific weight has been produced which can successfully resist the action of sea water. There are, however, many parts of a ship where sea water has little chance of doing damage. Between deck-beams, pillars, plating of bulkheads, etc., also deck-houses in light-weather ships, are fairly clear from this corrosive action.

Taking mild steel at three times the specific weight of aluminium, it would, for strength, be preferable to adopt the latter metal in many cases even at one-half of the ultimate strength. Even if its thickness were twice that of mild steel, it would be more rigid, while it would be one-third lighter. Mr. Yarrow, in his paper on aluminium torpedo boats, gave the tensile strength of aluminium alloyed with 6 per cent of copper as 14 tons to 16 tons.

It may be interesting now to see what effect upon the design of a 10,000-ton ship the adoption of nickel steel would have. It may be assumed that nickel steel, 50 per cent stronger than mild steel, can be produced with certainty. The relative weight of parts subjected to longitudinal stress may be reduced 33 1-3 per cent. If we assume that to resist compressive strains we have to reduce frame spacing, and can only take advantage of the increased strength of the material to the extent of one-half, we shall only gain 16 2-3 per cent in transverse framing material. The total gain in a 10,000-ton ship will be 1,000 tons on a weight of 6,000 tons—this is 16 2-3 per cent. It was found in passing from iron to mild steel that from 1 1-4 to 3 1-2 per cent was added by increased weight of butt straps, laps, etc., and though a smaller percentage would probably be added in this case, some allowance should be made. It seems as if from 14 per cent to 15 per cent of the weight of steel could be saved. This reduction in the weight of hull can be used to increase weight of machinery and coal. The extra speed resulting therefrom in a 20-knot ship will be 1 1-4 knot with an extra total coal consumption of 13 per cent. To produce a mild steel vessel carrying the same dead weight of cargo, and having 21 1-4 knots speed, the dimensions would have to be increased by 10 per cent, the horse power by 40 per cent, the first cost by 20 per cent, say $350,000, (supposing passenger accommodation to remain the same). Supposing the cost of workmanship is the same in a nickel steel vessel of the same dimensions as in one of mild steel (it will probably be less), we should have as the only difference in first cost of the two vessels that between 6,000 tons of mild steel and 5,000 tons of nickel steel. The former might cost $200,000, but the latter could hardly cost $200,000 plus $350,000=$550,000, and anything below this would be in favor of the nickel steel ship, both in economy of first cost and in economy of upkeep. The coal bill in the mild steel ship would be 19 1-2 per cent more than in the nickel steel ship. The 5,000 tons of nickel steel could probably be bought at present for $375,000, leaving a balance of $175,000 of saving.

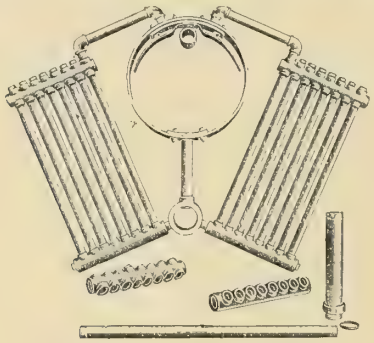
These figures are given to show the great value which increase of strength of material has upon the design of a ship and upon its first cost. In other types of ships savings in weight and engine power could be effected. In the low powered ships the gain would be less. Take the case of a 14 knot Atlantic liner of about 7,000 tons in addition to coal to do her voyage. She could carry 10 per cent, say 700 tons, more cargo if built of nickel steel. A mild steel vessel large enough to carry this extra cargo and maintain the same speed would cost $50,000 more. This, added to the cost of the mild steel in the vessel carrying 7,000 tons, would give a sum which would enable the builder to pay $45 per ton for the nickel steel. The extra cost at $75 per ton would be about 15 per cent of the first cost of the vessel. As there would be only 5 per cent less of coal and machinery expenses paid out to repay the extra first cost, it is doubtful whether, at $75 per ton in a vessel of this size, it would pay to build in nickel steel. It will be of interest to know what chance there is of this material being produced much more cheaply. No reference has been made to reductions in weight of machinery due to the adoption of nickel steel and their effect upon design.

72495

IMPROVED APPARATUS.

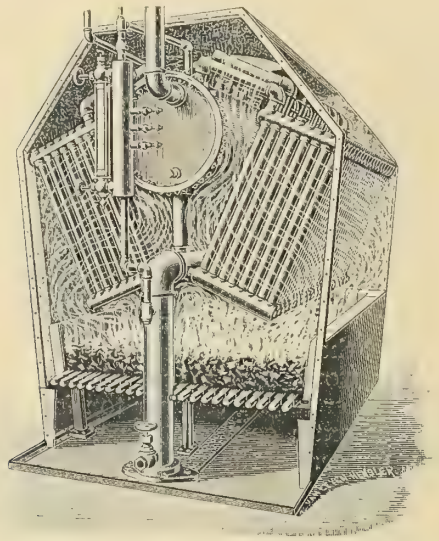
The "Detroit" Water Tube Boiler.

The "Detroit" water-tube boiler consists of one large upper drum, connected for its entire length to the water distributing pipe, below and parallel



DRUM AND CONNECTIONS.

with it, by means of one row of vertical pipes for down flow of water. In either side of the water distributor the lower tube manifolds are screwed in, and from these the tubes proper continue to the upper manifolds, which are connected to the top part of the drum with right-and-left nipples. The tubes are inserted through the upper manifolds with right hand threads, the top end of the tubes being so enlarged that both ends engage at the same time. To each end of the water distributor there is attached a sediment pocket, extending to the floor. To this is attached a foot or flange for supporting and fastening the boiler, which is also supported at the sides by the casing, the latter being fastened to the plugs in the upper



"DETROIT" BOILER WITH CASING REMOVED.

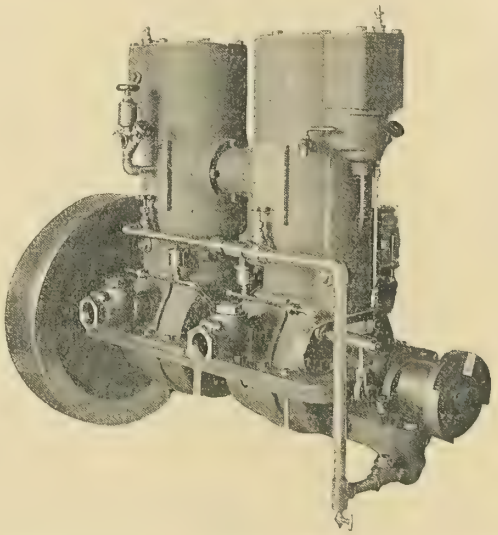
manifolds. The manifolds are placed so close together that the flame has to pass first to the outside, thence toward the center, thus causing an upward circulation in the outer row of tubes, these being exposed to the hottest fire, and a downward in those nearest the drum, hence the steam is partially separated from the water in the upper manifolds before it enters the drum, which is fitted with baffle-plates and dry-pipe. The boiler is the invention of H. H. Taylor, and is manufactured by the Detroit Screw Works, 49 Riopelle St., Detroit, Mich.

Truscott Two-Cylinder "Vapor" Engine.

The illustration herewith shows a two-cylinder Truscott "vapor" motor ready for installation in a launch or motor boat. The construction is such that the engine can be set far back in the boat, thus giving more room for passengers. The working parts are cased in, as when running, the motion of the crank is used to assist in mixing the charge of gasoline vapor and air preparatory to its entrance into the cylinder above the piston. The motion is always in one direction, and consequently a reversing propeller is used, operated by a convenient lever inboard. In boats fitted with this motor the supply of gasoline is carried in a tank in the bow and is piped aft in the form of vapor, produced in a special apparatus. Materials and workmanship are guaranteed by the builders, the Truscott Boat Manufacturing Co., St. Joseph, Mich.

Lee Oil Distributing Projectile.

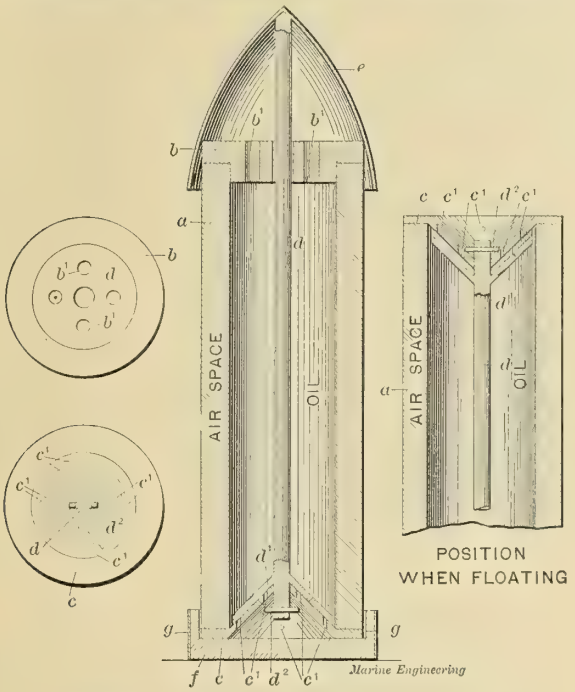
The Lee oil distributing projectile is intended to throw oil to windward in heavy weather for the purpose of quieting the waves. It is made to fit a Lyle gun and can be used on any vessel carrying such a gun of standard bore. For vessels laid to, light-ships at anchor, and in cases of rescue when boats must be lowered, it should



TRUSCOTT TWO-CYLINDER "VAPOR" ENGINE.

be very valuable. The projectile is made of tin tubes, one inside the other, with an air space between to give it buoyancy. A conical head is provided for the forward end and to this head a rod is attached which passes through the pro-

jectile to the other end, where a simple conical valve covers a valve seat with small holes in it. The forward end is made the heavier by a piece of metal, also with holes through it, and this weight is intended to keep the end forward during flight and also to make the projectile float in a perpendicular position after it has been thrown

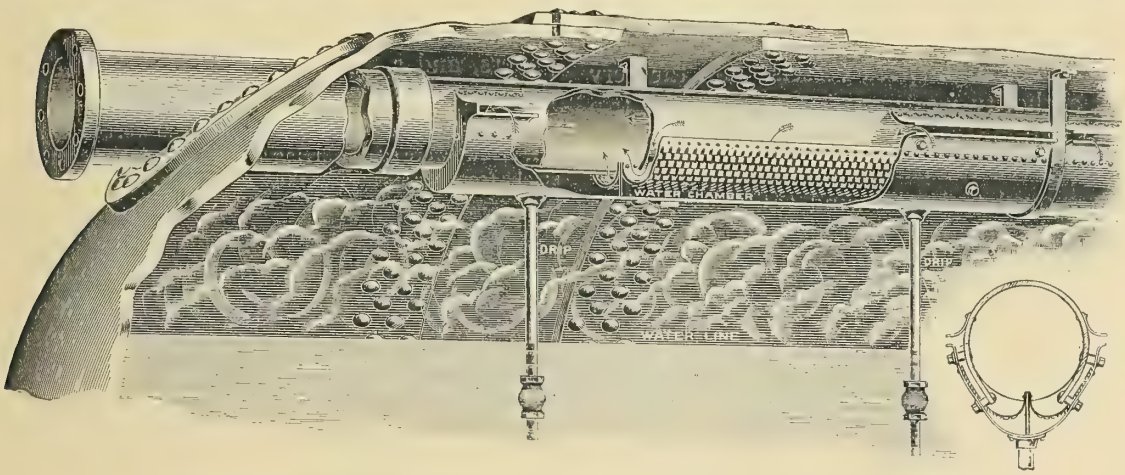


LEE OIL DISTRIBUTING PROJECTILE.

from the gun and fallen into the water. After filling with suitable oil, the projectile is placed in the gun, sufficient powder being used to throw it the distance required. After making its flight the projectile plunges into the water, but rises at once to the surface and floats head downwards. The conical head with rod falls by its own weight, opening the valve at what is now the upper end. The water now enters through the holes in the lower end and displaces the oil which passes out of the holes in the upper end and the oil is spread upon the sea and carried to leeward making rollers of the breaking waves. The aim has been to make a cheap but effective device. The cap on the end, shown in the cut, is to receive the impulse of the powder and falls off on leaving the gun. The inverted cut shows the position when floating and the valve open for passage of oil. The projectile was designed and patented by William W. Lee, of Northampton, Mass.

Separator and Dry Pipe Combined.

We show herewith engravings of a new separator designed especially for marine boilers. It consists in the main of the combination of separating device in connection with a dry pipe. Instead of steam entering through holes on top or bottom of the dry pipe the steam enters through a narrow slit at a point about midway along each side. These slits are protected by an out turned lip both above and below, so that water splashed up from below or dashed down by striking the shell above, is thrown away from the slit, and however much the water may be thrown about, but very little can enter at any one time, and to capture and remove that little the following provision is made: After the steam enters the inlet it is forced to pass between two walls which are only just far enough apart to give ample passage, and the lower side of this passage is covered by a sieve. This sieve is made of perforated sheet metal, and in a sort of rat-trap way so that water can be passed through it but cannot be picked up again by the steam. The steam robbed of its water enters the dry pipe and so passes out while the water collects in the lower chamber, passes down through drain pipes and check valves into the water below. The water chamber is divided by a partition to prevent the water which is gathered on one side from going over and through the sieve on the other. This separator is being put on the market by the Direct Separator Company, of Syracuse, N. Y.



COMBINED DRY PIPE AND SEPARATOR FITTED IN MARINE BOILER.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative,
S. W. ANNESS,
Philadelphia, Pa., Bourse Bldg.

Western Representatives.
L. L. CLINE & CO.,
Detroit, Mich., 47 Hodges Bldg.;
Chicago, Ill., 305 Fisher Bldg.

Traveling Representatives,
E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

WHAT'S the matter with the much boasted superiority of British engineering and ship building skill? The conventional reply can hardly be made, at this time, with accuracy. Not long ago the English technical papers had long accounts of the "largest" side wheel steamer afloat, viz., the "Empress Queen." She was truly a wonderful craft according to the modest London editors. From advices which we have received from her home port she is indeed a wonderful failure. This vessel, which was illustrated and described in our issue of June last, was built for fast passenger traffic between Liverpool and Douglas, Isle of Man, a route which has long been noted for high-speed vessels. On the very highest authority we learn that on her trial trip the most extraordinary precautions were taken to get speed, even the canvas on the flying bridge being removed to lessen wind resistance. She succeeded in doing 23.5 knots, but was nearly shaken to pieces in the attempt, and had to go back to the builders' yard to be strengthened. After she came out 22 knots was the best performance. In running at sea she is so down by the head that the forward promenade decks cannot be used by the passengers, unless they desire a continuous shower bath. And although run at enormous expense we learn that her best performance between Liverpool and Douglas is only two minutes better than that of the "Queen Victoria," a seven-year-old boat. While this is in mind a despatch from Valparaiso says that a torpedo-boat destroyer built in England for the Chilian Government was found to be so defective in construction as to be absolutely worthless. Then reports from across the sea tell of the unseaworthiness of the ferryboat Chebucto, built in Scotland to ply between Halifax and Dartmouth, Nova Scotia. The first time she started west across the Atlantic she had to put back because the crew refused to proceed. A lot of metal was worked into her in the builder's yard, and on her second attempt she was obliged to put into the Azores, damaged and leaking. There she will remain until some fine day in the spring, when, if the water is not too rough, she may reach Halifax and not the bed of the ocean. About this time, too, comes a report from Havana stating that the big floating dock built in England for the Spanish Government has got tired of floating, after her long tow across the Atlantic, and is now resting contentedly on the bottom. Add to all this the engineers' strike and the transatlantic records under the German flag and it would appear Britain has troubles of her own.

EVERY little while the daily papers, of this city at least, give much space, with hysterical head lines, to the narration of a "race" between Cunard and American liners. These descriptions invariably commence with an account of the sighting of one steamship by the other, and the subsequent efforts of the one to overhaul the other. The vessels are invariably described as giving forth immense volumes of smoke from their funnels. A recent brush between the St. Paul and Campania was so described in several papers, and a quotation from one will serve for the others:

> The engineers and firemen of the St. Paul worked with a will. The screws were sent whirring around faster than ever, and the smoke from her stacks was thick as it trailed in the wind behind the steamer.

Sometimes these descriptions are accompanied by fanciful sketches, showing an inky black trail following the liner. But science and the poetic spirit do not agree, and so far as the American liners are concerned the smoke exists only in the mind of the reporter. These boats happen to be equipped with the Howden draft and an almost perfect combustion is the result. They do not smoke for the very good reason that no smoke is manufactured in the process of converting coal into horse power. If the Chief Engineer of the St. Paul wanted to make things lively aboard the Campania, he would take precious good care that the heat value of his coal

did not pass out of the smoke pipes in the form of unconsumed carbon. Heavier firing would be accompanied by a speeding up of the induced draft fans, and the process of combustion would be just as perfectly carried out as though the ship were under slow speed approaching her dock. A slight brown haze might be occasionally observable drifting aft from the funnels, but it is a safe bet to make that a vessel clouding the horizon with smoke is not an American liner.

A CONTRACT was recently closed by the Bath Iron Works, Bath, Me., for a steel steamer the construction of which marks a very bright page in the history of American shipping. This is the first steel tramp steamer, designed by Americans, built by Americans, of American material and to sail under the American flag. While others have talked of ways and means of restoring the prestige of this nation as a freight carrier for the world at large, it has remained for a New York firm to take positive action in placing the order for this vessel. It is a pleasure to place on record the name of this patriotic firm, Messrs. Miller, Bull & Knowlton, of New York, by whose enterprise and good judgment the first step toward restoring to its rightful place the American merchant flag afloat has been taken. The construction of this vessel is consequently of intense interest to all who hope for the upbuilding and development of the merchant marine. In all lines of mechanical work America is making immense advances and corresponding inroads on the trade of other nations. Shipping has been neglected hitherto, but there are now very hopeful indications of an awakening. Abroad the tramp steamer has received the attention of the ablest naval architects and engineers, and a form of vessel has been evolved which is comparatively cheap to construct and maintain, and is perfectly seaworthy and economical. In designing the new vessel the Bath Iron Works has apparently not only availed itself of these experiences, but with native ingenuity has added many conveniences and useful modifications. It is of interest to note here that A. Sewell & Co., of Bath, have begun work on a new sailing vessel to be added to their well known fleet. This will also be built of steel, made in this country to the specifications of American ship builders. The firm already owns the large steel ship Dirigo, which, it will be remembered, was constructed here out of material shipped from England.

IN a recent issue we published an article by Prof. Durand, on the experimental tank, in which the author, referring to the long continued use of the tanks in existence, wrote:

> There is, in fact, on file in the archives of these various establishments an amount of data which, if massed together, properly analyzed and reduced to common standards of measurement, would render unnecessary a vast amount of work which is currently carried on in the various places individually. The causes of this duplication are commercial and well known.

This covers the ground very exactly, giving a statement of conditions and the reason therefor. But the statement is not only applicable to the design of vessels, but to a much greater extent to their operation. How many full powered vessels are there, for example, in daily service, compared with the number of tanks in use? and each of these vessels is more or less an experimental station. The superintending engineer of a line is as watchful of cause and effect as is the chief constructor of any yard. But for "commercial" reasons he is dumb outside the precincts of his company's office. Of course, the company which employs him benefits largely from the experiences which come under his observation, and from which he draws conclusions for changes in practice. How much greater would the benefits be to the profession at large were the experiences of each line, or indeed each vessel, properly reduced to a common basis of observation and made public? Take the case of transatlantic liners for example. Each trip across the ocean is a trial trip—one prolonged test. Not a trial trip of the vessel as a whole, perhaps, but of some new piece of apparatus or method of practice, which is thus put through the most severe and accurate of all tests—practical use. Every pound of coal consumed, or pound of water evaporated, every gallon of oil or quantity of other stores, is accounted for. Pressures and temperatures are noted and recorded. There is nothing left to guess work. Thus data of an immensely valuable sort is accumulated. Exact conclusions can be reached, not by mathematical processes or laboratory determinations, but by the actual working of the ship under service conditions. "Commerce" steps in, however, and blocks the way of science. Such results have only been secured by the expenditure of large sums, which figure in the operating expenses account, and consequently belong to the stockholders. So the unformed experiences of one company, which may be just what are needed to perfect a process unsuccessfully undertaken by another company, go for naught.

CORRESPONDENCE.

[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Replies to Walschaert Valve Gear Inquiry.

In answer to the inquiry concerning the Walschaert gear, given in the November number of your journal, I will give both the valve-ellipse and the polar diagrams for such a gear, as applied to a locomotive on the Revere Beach and Lynn R. R. Fig. 1 gives a diagrammatic representation of the gear, where A is the center of the driver axle, B is the center of the crank-pin and C is the center of the wrist-pin. D is a point on the cross-head which is connected by a rod D E to the combining-lever E G, G being a point of the valve-spindle, which is guided on a horizontal line. The point H is on the end of a return-crank so placed as to make the line A H at right angles to the crank A B; the point H corresponds to the center of an eccentric with no angular advance, and such an eccentric can be used instead of a return crank when that is more convenient. H gives motion to the curved and slotted rocking-lever J L, which is pivoted at L. The block K on the radius-rod F K may be placed at any place in the curved slot by means of the reversing mechanism R P N. The radius rod imparts motion to the point F of the combining-lever, so that the valve derives part of its motion from the cross-head and part from the point H. The motion from the cross-head is reversed by the combining-lever, so that it is equivalent to the motion from an eccentric with 90° angular advance, while the motion from H is equivalent to that from an eccentric with no angular advance. The resultant motion of the valve, obtained by combining the motion from these two sources, is equivalent to that of a shifting eccentric or a link motion, and is therefore proper for the reversing and expansion valve-gear of a locomotive. When the block K is at L, the motion of the valve is derived solely from the cross-head of the engine, and the maximum valve displacement is equal to the lap plus the lead. This valve displacement occurs at the dead point just as for a valve controlled by the mid-gear grade of a link motion. The radius rod F K is equal in length to the radius of the slotted-lever, consequently as that lever is erect when the engine is at a dead-point (which follows from the fact that H A B is a right angle) the block may then pass from end to end of the slot without moving the

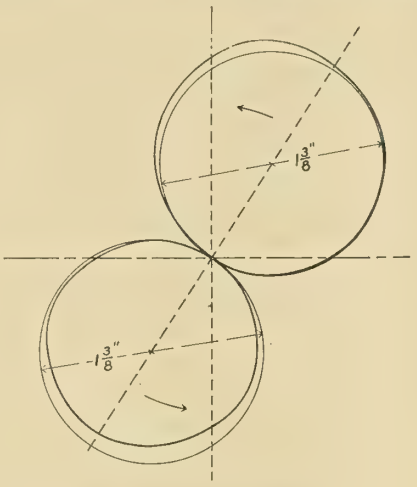


FIG. 3.—POLAR DIAGRAM.

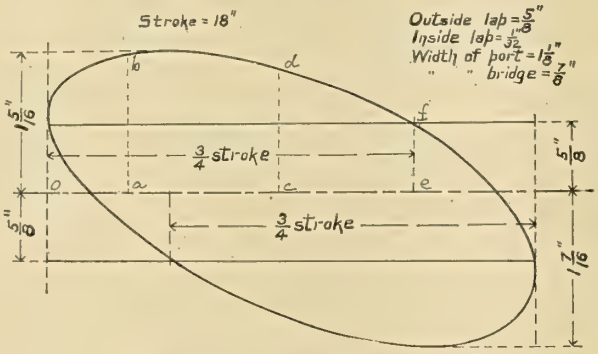


FIG. 2.—VALVE ELLIPSE.

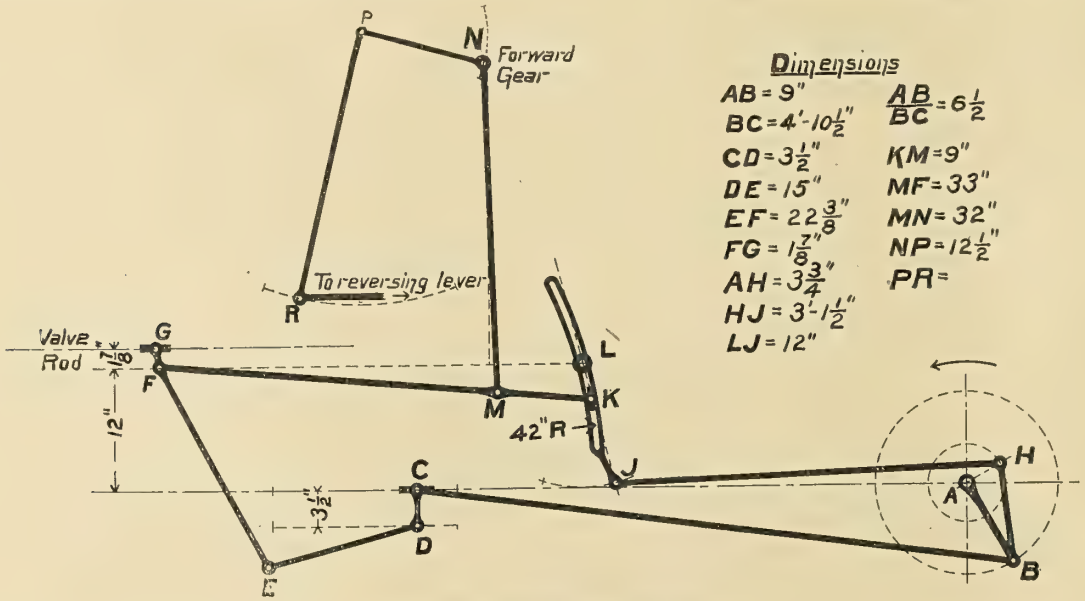


FIG. 1.—WALSCHAERT VALVE GEAR.

valve; that is, the lead for this gear, as for all radial valve-gears, is constant. When the block is placed at some other point than L, for example at K, the valve has a motion which gives a proper distribution of steam for the forward motion of the engine, as represented by the arrow, the point of cut-off depending on the proportions of the gear and on the distance K L of the block from the pivot L. If the block is raised above L the engine will be reversed. The only way of studying the motion of a valve controlled by the Walschaert gear, or by any radial valve gear, is to draw a diagram like Fig. 1 with successive positions of the cross-head and find the corresponding positions of the valve; or a carefully made wooden model may be used for the same purpose. Fig. 2 is a valve ellipse representing the motions of the piston and valve for the gear shown by Fig. 1. For several piston positions, measured from the beginning of the stroke, such as o a and o c, the corresponding valve displacements from mid-position, a b and c d are obtained as just described; and these valve displacements are set up as ordinates. A smooth oval curve drawn through b, d and similar points enables us to find at once the valve displacement for any piston position. Conversely we may find the piston position corresponding to any valve displacement. For example, a line drawn at a distance of five-eighths of an inch (the outside lap of the valve, from the axis, cuts the oval at f and shows that the cut-off occurs at three-fourths of the stroke. A similar construction shows that the cut-off occurs at three-fourths stroke for the return stroke also. The valve-ellipse drawn is for a late cut-off, nearly full gear. Similar ellipses for earlier grades of cut-off are likely in this case to show some inequality of cut-off. But as the valve gets part of its motion from the cross-head of the engine, equalization of cut-off is comparatively easy. The maximum valve displacement is somewhat unequal, being in this case 1 5-16 in. for the forward stroke and 1 7-16 in. for the return stroke. In Fig. 3 the valve displacements corresponding to various crank angles are laid off along the center line of the crank so as to give polar diagrams similar to Zeuner valve circles. The diagrams thus obtained are irregular ovals, which, however, do not differ very widely from circles having the diameter of 1 3-8 in., as shown on the diagram. The diagram for the forward stroke is below, and represents the displacements of the valve while the crank is below the center of the driver axle; the upper diagram represents the displacements of the valve for the return stroke while the crank is above the axle. The curved and slotted rocker has a general resemblance to the link of a Stephenson link-motion, and the gear is sometimes erroneously called a link-motion, but though its effect is the same as that of a link-motion, the principles of its construction are radically different. The determination of the proper proportion of the parts of the gear and of the effects of modification can be determined by trial only, making use either of a series of diagrams like Fig. 1 or of a model, which can be conveniently made of wooden rods.

C. H. PEABODY.

In reply to your correspondent who wishes information relating to the Walschaert valve gear, I would say that he will find the subject discussed, with diagrams and explanatory matter, in the following books:

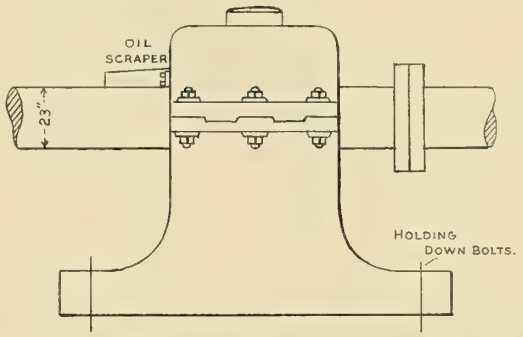
Treatise on Valve Gears.....	Zeuner	p. 127
Link and Valve Motions.....	Auchincloss	p. 121
Valve Gears for Steam Engines.	Peabody	p. 88
Appareils de Distribution par Tiroirs	Pichault	p. 141

This gear is equivalent to that known as the link of Hensinger Von Waldegg, and in Zeuner it appears under that name, while Pichault refers to it under both names, and the other authors mentioned refer to it as the Walschaert gear. D.

I notice that a party signing "H." requests information regarding the Walschaert valve motion, and I would say that it is described, and manner of laying out the diagram given, in "Link and Valve Motions," by W. S. Auchincloss. The Walschaert valve motion is used on some European locomotives and also on some of the compressed air locomotives in this country, where it is impracticable to put in the ordinary link. SCHENECTADY, N. Y.

Device for Saving Oil in Shaft Alley.

When on the S.S. Campania recently, I noticed a simple yet practical device intended to prevent the lubricant from traveling along the main shaft, a very undesirable thing, as it means a dirty looking shaft and men's time to keep it clean. The diameter of the main shaft is about 23 in. At the side of each of the bearings a small piece of steel, or wrought iron, which has an elbow (at an acute angle) on it, is bolted to



OIL SCRAPER ATTACHED TO PROPELLER SHAFT BEARING.

the cap of the bearing by two small set screws, probably 3-8 in. The long end of this angle piece is about 5 in. It is about 3-8 in. thick and 1 in. wide. When in place, this piece is made to just touch the shaft, and is placed at a slight angle with the center of the shaft. This simple device has acted quite successfully, and below the shaft is a receiving tank, into which the oil now drops, instead of traveling along the shaft for two or three feet, as formerly. I never saw this before and it struck me as rather ingenious. I enclose sketch. J. J. S.

A Response to Inquiry of "B. T. U."

With regard to the inquiry of your correspondent "B. T. U." in the October issue, our conclusion on this matter is that no definite reliable data is available regarding the conductivity of metals in Feed Heaters, Condensers, etc. Our experience is that the conductivity varies considerably, according to the construction of the apparatus. We would refer him to D. K. Clark's "Rules, Tables and Data," where a number of results are given, obtained by various experimenters. This will be found in the section of "Applications of Heat." G. & J. WEIR, LTD.,

GLASGOW, SCOTLAND.

(The work referred to is entitled "A Manual of Rules, Tables and Data for Mechanical Engineers," by Daniel Kinnear Clark, M.I.C.E., published by Blackie and Son, Old Bailey, London, E. C.—Ed.)

Regarding the Position of Screw Propellers.

As there is a great difference of opinion on the following problem, I would like some of your readers to discuss it. Is it disadvantageous, and to what extent, in a twin screw steamer, to have the shafts farther apart at wheels than at engines; or, in the case of a single wheel, to have shaft say 3 ft. off the horizontal? PROPELLER.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—VI.

BY WM. BAXTER, JR.

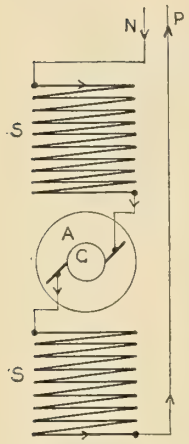


FIG. 36.

In addition to the four types of two pole machines given in the preceding article, we present herewith three more, which complete the list of prominent types. Machines like Fig. 31 were made extensively, in former days, by the Weston Company, in this country, and by Siemens & Halske and others, in Europe. Fig. 32 is the Gramme machine, which was made in several countries on the other side of the Atlantic, and is still made as an arc light machine in this country, being, in fact, one of the most prominent machines of that class. The Brush "arc" machine is the most prominent of type 33. These three machines are of the two circuit variety, and differ from each other only in that the armature is either changed in form, or in the position of its axis. In Figs. 32 and 33 will be noticed the shaft runs parallel with the length of the frame, while in Fig. 31 it is transverse. The only difference between 31 and 32 is in the position of the shaft, for although as a rule a drum armature is used with the former and a ring armature with the latter, either style of armature may be used in both. The difference between Figs. 33 and 32 is that the field magnets on opposite sides, instead of coming together to form single pole pieces, are separated and the armature rotates between them.

As was shown in the last article, a single magnetic circuit machine should give the best results, theoretically, but in practice the difference is not very great, owing to the fact that when two circuits are used the area of each one can be made more than half the area of the single circuit without any difficulty, and therefore the total number of lines of force can be obtained with a less number per square inch of cross section, hence with a smaller number of turns of wire in the coil. In this way the apparent gain of the single circuit type is largely offset, and with sufficient skill on the part of the designer can be wholly offset.

The amount of electric energy required to magnetize the machine is not the only point that determines its efficiency. The magnetism may be developed with a small expenditure of energy, but it may not be all utilized, and the loss in this direction may be far greater than the gain in the former. The lines of force developed by a coil tend, when they emerge from it, to find their way back to the other end by the easiest path possible, and if there is any chance for them to return to the coil by a path outside of the armature with less effort, they will do so, and therefore the full effect of the magnetizing current will not be made available. A parallel to this may be found in a steam engine which is so well designed that it should work very economically, but is provided with a piston of such construction that it cannot be kept tight, therefore, the loss due to the leakage of steam from one side to the other is sufficient to overbalance all the good points, and render the engine as a whole decidedly inferior. The difference between a steam engine with a defective piston and an electric machine in which the magnetism of the field can leak by the armature is that the former can be remedied, if need be, by the substitution of a better piston, but in the electrical machine about the only remedy is to replace the field, and this would be very nearly equivalent to replacing the whole machine.

The difference between an efficient and an inefficient electric machine is not dependent upon the type to which it belongs except in a very small degree, but to the relative proportion and shape of the various parts.

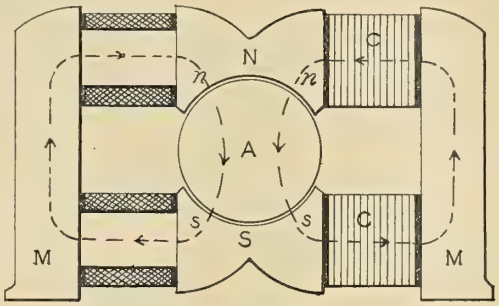


FIG. 31.

From what has been said in this and the preceding article it can be seen how the energy required to develop the magnetism can be reduced to the lowest point, and in a future article we will show how to utilize in the armature the greatest proportion of the

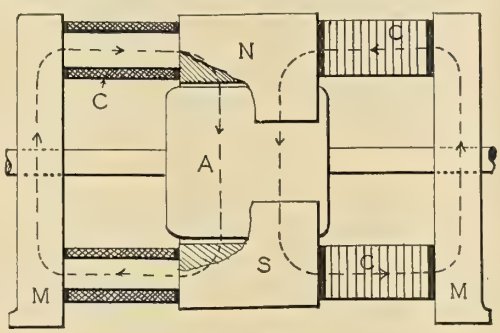


FIG. 32.

magnetism. We will now explain the manner in which the magnetizing coils are wound, and how to determine what ends should be connected when there are a number of coils.

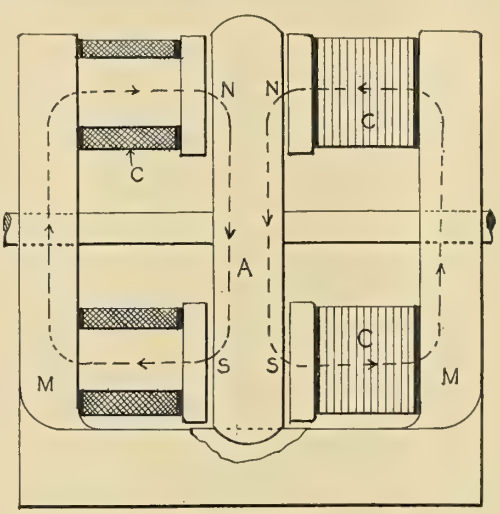


FIG. 33.

In the simplest form of machine, that shown in Fig. 27 of the last article, the coils must be wound so that each one develops lines of force oppositely directed

in space; if not, one will act against the other, and there will be no lines of force to pass through the armature. In Figs. 28, 29 and 30 the winding of the coils must be such as to develop lines of force in the same direction through space. In Figs. 31, 32 and 33 the coils of each circuit must be wound so as to develop lines of force oppositely directed through space, but the relation of the coils of the two circuits must

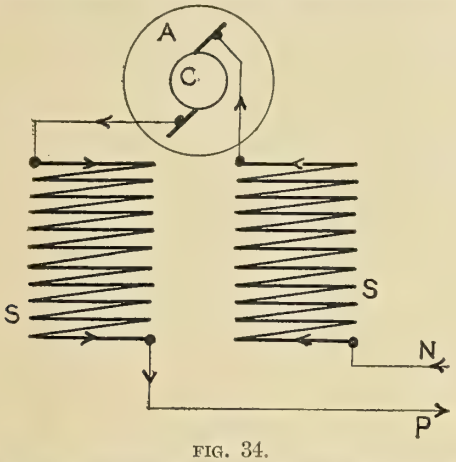


FIG. 34.

be such that the direction of the lines of force of both circuits will be the same through space. How to accomplish this can be made clear by the aid of Figs. 34, 35, 36 and 37.

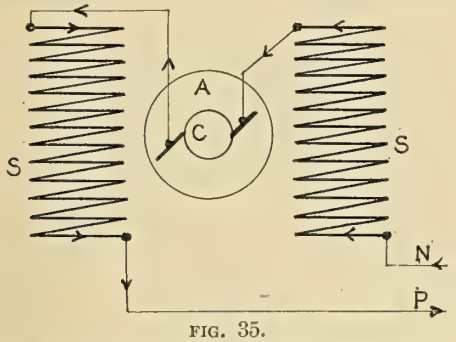


FIG. 35.

Fig. 34 is a diagrammatic representation of the field coils and armature of machines of the type shown in Fig. 27. Fig. 35 corresponds to types 28 and 30, Fig. 36 to type 29, and Fig. 37 to types 31, 32 and 33. In all

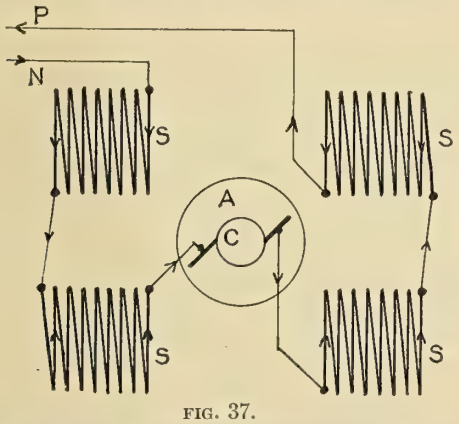


FIG. 37.

these diagrams A represents the armature, C the commutator and S the field coils. P and N are the wires through which the current passes to the outside circuit; and the arrow heads on these may be taken to represent the binding posts to which the leading off mains are attached.

Considering Fig. 34 it is evident that, as the coil on the left side must magnetize the field with an N pole at the top, while the coil on the right must develop an S pole at the top, the direction of the current through the wire in both must be in opposite directions; that is if it flows through one in the direction of a right hand screw, its direction through the other must be that of a left hand screw; but, as the current passes out of the right hand coil at the top, and enters the left hand coil at the top also, the wire must be wound in the same direction in both coils. To understand this more clearly, suppose the right hand coil were revolved around through one half turn so as to come directly on top of the left hand coil, then the two coils could be regarded as halves of one and the same coil, and the wire in each half would be wound in the same direction, and the current through both would also be in the same direction. To make the matter still clearer, suppose we wound a single coil equal in length to the two coils, and pulled this apart in the middle and bent the two halves around, so that they would come side by side. All we would have to do then would be to cut the wire at this middle point where we bent the coil, and connect the ends with the two brushes resting upon the commutator C.

In Fig. 35 the direction of the current through each coil would have to be the same. This arises from the fact that while in Fig. 34 one coil develops an N pole at the top and the other an S pole, in Fig. 35 both coils develop like poles at the top.

In Fig. 36 the current must flow in the same direction through both coils, notwithstanding that this is also a single magnetic circuit machine, the same as Fig. 34. The current through both coils is the same in direction, because one is on top of the other, and, as was explained in connection with Fig. 34, if the current is in the same direction in both coils, when one is on top of the other, it will be in opposite directions when they are bent around side by side. The two coils in this figure may be regarded as halves of the same coil, spread apart in the middle (the wire being unwound sufficiently at this point to permit the halves to be drawn apart), the wire being cut in two at this point and the ends connected with the brushes resting on the commutator.

Fig. 37 is the winding diagram for Figs. 31, 32 and 33, and by studying these figures we will see that the direction of the current through the four coils must be such that the two right hand coils will develop an N pole at the top and an S pole at the bottom on the left hand side of the coils, and that the coils on the left side must develop the same poles on the right hand side of the coils. This being the case, the winding of the two coils on the left must be the same as that of the coils in Fig. 34, and that of the left hand pair must be the opposite of this.

It will be noticed that in all these diagrams the brushes do not rest upon the commutator in the same place. In Fig. 34 they are on top and bottom and in the others on the sides. This change in position is due to the fact that in every case they must be opposite the spaces between the poles unless the connections between the armature and commutator are carried around the circle, as is done in the Edison and some other machines, for the purpose of bringing the brushes into a more accessible position.

In making the connection between the ends of the field coils and the commutator brushes it makes no difference to which brush either end be carried, unless it is desired that the armature revolve in a certain direction, but as the direction of rotation can be reversed by simply reversing these connections, it is generally less trouble to determine the proper relation by actual trial than by tracing out the direction of the current through the armature. The latter method is also simple, and as it is desirable to know the relation between the direction of the current in armature and field, the way of determining it will be explained at the proper time.

ENGINEERS' DICTIONARY.

Air Casing.—A casing of sheet steel or iron, placed about the smoke pipe where it passes through the decks, or from the fireroom to the upper deck. Its purpose is to provide protection from the heat of the pipe, and ventilation from the fireroom to the external air through the annular space between the pipe and casing.

Air Chamber or *Air Vessel.*—A chamber connected with the delivery side of reciprocating pumps handling liquid, and containing air in its upper part. The average pressure of the air thus imprisoned will be that on the delivery side of the pump. Under this pressure the air will become compressed into a relatively small volume. As the pressure due to the pump piston tends to fall between strokes, the compressed air will expand and thus tend to continue the delivery, until the piston again takes up the work on the following stroke. The presence of this body of air, capable of compression or expansion, is also valuable for the absorption of shocks in the delivery pipe, due to the irregular speed of the pump, or the irregular yielding of the resistance against which it is working. As a safe general rule the volume of the air chamber may be made about the same as that of the water cylinder of the pump.

Air Cock.—In general, any cock used to control the flow of air. In particular, a small cock on the delivery side of pumps, for the escape of air and to show if the pump is operating properly.

Air Duct.—A closed passage or channel for leading air to or from blowers and ventilating fans.

Air Lock.—An arrangement of double doors and intermediate chamber or lock A (Fig. 1), with valves

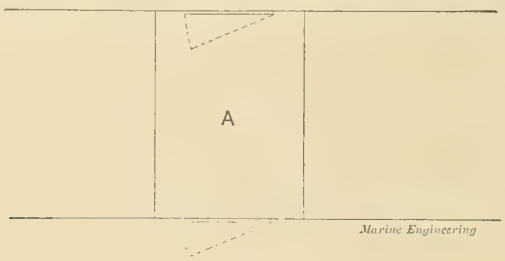


FIG. 1.

for equalizing the pressure within with that on either side. By this means passage to and from firerooms, under forced draft pressure, may be effected.

Air Pump,—A pump for the removal of air, condensed water and vapor from the condenser, in order to maintain the vacuum formed by the condensation of the steam. The air comes from leaky joints, and from the gradual accumulation of the small amount naturally mixed with the feed water. The usual type of air pump is illustrated in Fig. 2[1]. A is the *piston* or *bucket* moving in the barrel B. The valves at C are known as *foot valves* and admit the contents of the condenser from below. Beginning with the piston in the position shown, the operation is as follows: As the piston rises the air and vapor in the space between it and the foot valves become rarified with a resultant decrease of pressure. Soon a point is reached where the pressure is decidedly greater in the condenser than in the space above the foot valves, and in answer to this difference of pressure the valves open and admit air vapor and water from the condenser. This operation terminates with the piston at the top of the stroke. On the return stroke the foot valves close, and the contents of the barrel are forced through the *bucket valves* at D to the space above. On the next stroke these contents are lifted and forced out through the *head* or *delivery valves* at E, where the air and vapor escape, and the water flows to the hot well whence it is sent by the feed pump back to the boiler. It is evident that the pressure in the condenser cannot be reduced below that necessary to raise the foot valves, so that for this reason, as well as for their more ready response to variation of pressure, they should be made as light as is consistent with a proper performance of their duty. Such valves in modern practice are usually made of light sheet metal, controlled by dished spiral springs. In older practice vulcanized rubber was commonly employed. It is also evident that the foot valves will respond the more quickly, the more rapidly the pressure above them decreases as the piston begins to rise, and hence the less the clearance space between the valves and piston when in its lowest position. The air pump has this peculiarity in its action, that the load per stroke and hence the resistance, usually decrease with an increase of speed, and increase with a decrease of speed. Hence, when the pump is operated by an independent engine, it may be liable, unless carefully designed, to race or run away to excessively high speeds, with a slight increase of pressure in the steam cylinder, or to slow down and stop with a like decrease. It is apparent also that a certain time will be needed for the

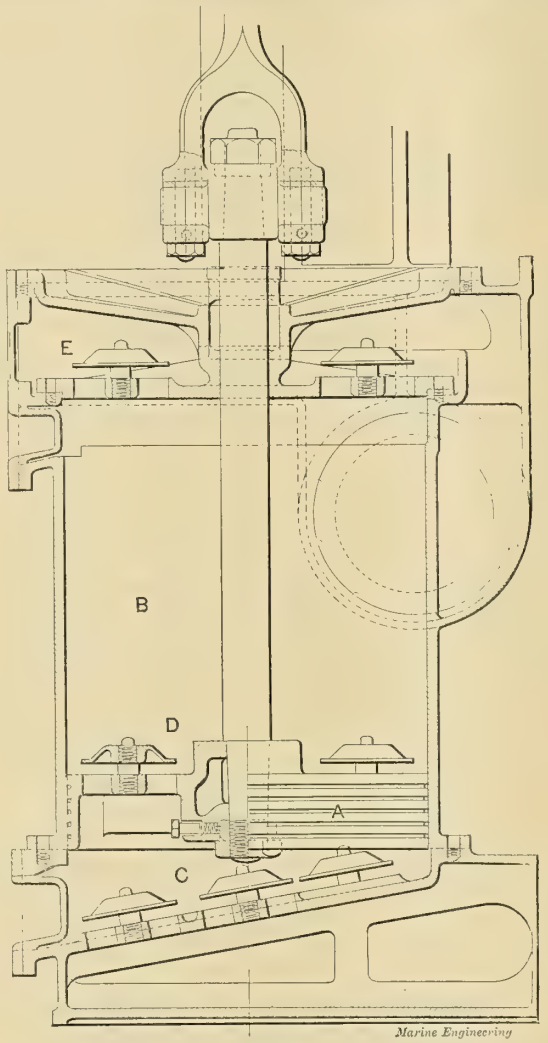


FIG. 2.

foot valves to open, and for the air, water and vapor to flow through. Hence, with excessive speeds, the valves may not have time to open between strokes, the vacuum will become poorer, and the condenser may become flooded with the condensed water. It thus follows that, with too high as well as with too low a speed, the vacuum will be poor, and the opera-

[1]The Rubber valves are not in place in the sketch.

tion of the pump unsatisfactory. The air pump may be driven either by an independent engine, or by attachment to the main engine. The attached air pump is usually operated by *air pump levers*, which derive their motion in most cases from the L.P. cross-head. The stroke of the pump is thus reduced to usually less than one-half that of the main engine. One of the advantages of the attached air pump is that the number of its strokes per minute is necessarily the same as for the main engine, and it can neither race nor slow down, on account of variations in its own resistance. A further advantage is that the power required for its operation is obtained more economically than if it were operated by a separate engine. The chief disadvantage of the attached air pump is that, with modern increase of revolutions, the speed may be too great for the best results from the pump, as usually designed. This, together with the advantage of having the condition of the condenser under control, independent of the main engine, is bringing about a more general use of the independent air pump, especially in war ship design. In such case the number of double strokes per minute is usually from 15 to 25, while the revolutions of the main engine may be from 100 to 200 or more. For special cases of torpedo boat practice, where the revolutions are very high, but it is desirable for simplicity and for the saving of space to use an attached air pump, a special type has been developed in which the water flows by gravity into the barrel through ports alternately opened and closed by the piston itself, which thus serves as its own valve. The air and vapor naturally expand and enter with the water, and the whole contents are forced out of the end of the barrel through delivery valves similar to those in the pump of usual type. With this design, air pumps may be successfully operated at speeds of 400 revolutions per minute and higher. A wide variation in practice exists in the design of the capacity of air pumps. The volume may be proportioned either to the power developed by the main engine, or to the volume of the L.P. cylinder. If v is the volume displaced by the air pump piston per stroke, n the number of double strokes, then we may put:

$$v = \frac{(\text{I. H. P.}) \times C}{n}$$

where for independent pumps c may vary from 50 to 100, and for attached pumps from 100 to 250.

Or, if V is the volume of the L.P. cylinder, we may put:

$$v = \frac{V}{10} \text{ to } \frac{V}{20}$$

The "Practical Engineer" pocket book, for 1898, published by the Technical Publishing Company, 31 Whitworth street, Manchester, England, is just what its name implies. It is a most convenient little work of 374 pages, in which is stored up ready for immediate use a great variety of data of the most practical character, such as would be needed daily by any constructing engineer ashore. To give a list of all the data the book contains would occupy much space, but a few of the leading divisions will give a correct idea of the contents. Tables of British and Foreign Measures; Boilers, including Construction, Incrustation, Tests and auxiliary apparatus, such as Feed Pumps, Injectors, etc.; Engines, giving rules for Proportions, Properties of Steam, Engine Testing and indicator work; also data regarding Steam Pipes, Strength of Materials, which included crank and propeller shafts, is followed by a chapter on Friction and data concerning methods of Power Transmission. Gas and Oil Engines are reviewed and Hydraulic Machinery also. A chapter on Workshop Practice takes note of the speeds of cutting tools. Hoisting Machinery, Mining Machinery and Electrical Engineering, all get considerable space. The only criticism which occurs to us is with reference to the typographical features of the work. It is as a whole badly printed on poor paper, but the low price, one shilling and sixpence, makes this, perhaps, excusable.

DURING THE MONTH.

The Commercial Cable Co. decided to erect new towers at Fire Island, Sandy Hook, and Highlands of Navesink, from which to report passing vessels.

The British torpedo-boat destroyer Crane is credited with a speed of 32.49 knots on the measured mile in a recent trial. Probably this was with the tide.

The new steamship Miami, built by the Cramps for Henry M. Flagler, to ply between Miami and Nassau, N. P., made a successful trip and will soon leave for her station.

A company formed to build the Parsons steam turbine has decided to establish extensive works at Wallsend-on-Tyne, on the east coast of England, where, not only turbine engines, but hulls will be built.

A contract has been drawn up between the Western Transit Company and the Detroit Dry Dock Company for the construction of a new 400 ft. steel steamer. She is intended to carry 5,000 tons on a 17 ft. draft.

A movement was started among the business men of St. Louis to establish a steel barge line to trade between St Louis and the Gulf. An estimate for $500,000 has been made and the larger part of this sum subscribed.

Fire destroyed the wooden steamer George Morley, on Lake Michigan, early in the month. She was bound light from Milwaukee to Chicago, and after she caught on fire was run ashore near Evanston. She was valued at $35,000.

French Naval authorities have included in the new shipbuilding program 112 first-class torpedo boats, of which about two dozen will be completed within a year. In destroyers they have decided upon a small number of boats of more than 300 tons.

The trip of the British cruiser Powerful from England to a China station is being watched with a considerable amount of interest, as she represents the largest installment of water-tube boilers in any fast vessel afloat, being fitted with those of the Belleville type.

A contract has been concluded between the Cramps and the Boston Fruit Company for the construction of four steel screw steamers of about 2,500 tons carrying capacity, which are intended to trade between the West Indies and Baltimore, Philadelphia, Boston, and New York.

Plans for a new form of automobile torpedo were approved by the British Naval authorities and experimental torpedoes are to be made. The new weapon is said to possess many advantages over the Whitehead. This same promise has often been made in the past, but so far the Whitehead retains its supremacy.

The British Government has let a contract to construct a harbor at Dover, on the southeast coast of England, directly opposite Calais, on the French side. The contract price is $20,000,000. It is the intention to use this harbor as the headquarters of the squadron of fast cruisers and torpedo boats, and also as a harbor of refuge in case of war.

There was a change of ownership of the Thingvalla line, which maintains a regular service between this port and Christiana, Copenhagen and Stettin. This is understood to make available a large amount of new capital, with the probability that additions will be made to the fleet, which now consists of the liners Norge, Hekla, Island, and Thingvalla.

An award of $18,000 has been made by the English courts to the Dominion liner Memnon for salvage services rendered to the Anchor liner Circassia, last September. The latter broke her shaft while east bound from New York and was towed several hundred miles to Queenstown by the Memnon. This division of the award was made: Owners, $13,250; Master, $1,750; and Crew, $3,000.

A direct steamship line to India was inaugurated by the sailing of the S.S. Sahara from the Atlantic Docks, in Brooklyn, with a cargo of steel rails, machinery and case oil. This line is established by the London firm of Bucknall Bros., and the agents here are Norton & Son of the Produce Exchange. Hitherto freight for points in India has been trans-shipped, going by way of British or Mediterranean ports.

The steam launch Ellide, built by Samuel Ayres & Son of Nyack, for E. Burgess Warren, from the designs of C. D. Mosher, was accepted by the owner. A bonus of $6,000 is said to have been paid by him for speed in excess of 30 miles an hour. Mr. Warren is credited with the proposition of offering the launch to the Navy Department for experimental work in connection with the construction of torpedo boats.

The steamer Rosedale, loaded with 60,000 bushels of wheat from Ft. William to Montreal, struck on the Charity shoal, near the head of the St. Lawrence river, and was abandoned. This vessel, which was owned by the Montreal Transportation Company, was built in England and cost about $75,000. She was said to have been the first steel vessel that ever carried a cargo from the British Isles through to Chicago.

While the Allen State liner State of Nebraska was on her way out of port, December 9, she was run into by the coal barge C. C. Chapman, in the channel just inside the Hook. The stubby bowsprit of the wooden barge struck the liner just abaft the port lighthouse and tore away a number of the cattle pens, many of the beasts escaping into the sea. Beyond some damage to the joiner work, no serious injury was sustained by the liner, which however put back for repairs.

Particulars of the machinery for Queen Victoria's new yacht were given out. Humphrey's Tennant & Co., London, are the contractors. The yacht is to be 380 ft. long, 50 ft. beam, and 18 ft. draft, and to displace about 4,600 tons. The hull will be built at the Royal Pembroke Dock Yard. The yacht is to be minutely subdivided into water-tight compartments and is to be sheathed. She will have twin screws, with four-cylinder, four-crank triple expansion engines. These will have cylinders 26 1-2 in., 44 1-2 in. and two 53 in. by 39 in. stroke. At 140 revolutions, with 250 lb. pressure, a total of 11,000 horse power is estimated. Steam will be generated in eighteen water-tube boilers of the Belleville type, having a total heating surface of 26,000 sq. ft. and grate area of 840 sq. ft. The boiler pressure will be 300 lb. per sq. in. reduced at the engines. The yacht will have three smoke stacks and two pole masts.

The big freight steamer Monarch of Elder, Demster & Co., met with a run of bad luck upon her first eastward voyage. She left New Orleans November 5, for Liverpool, with a cargo which included 22,535 bales of cotton, 60,000 bushels of corn, 11,200 sacks of cotton seed meal, and 29,068 pieces of oak staves, which was probably the largest cargo ever loaded at New Orleans. When a little way out to sea, a mishap to the machinery compelled the steamer to put back for repairs. When she came to anchor again in port she was run into by the steamer Kinsale, which had cleared with a cargo of corn for Rouen, France. The rudder chains of the Kinsale had snapped, and while unmanageable she crashed into the starboard side of the Monarch. Both vessels were considerably damaged, a hole about 10 ft. square being torn in the bow of the Kinsale and several plates of the Monarch were started, letting in a considerable amount of water. The Kinsale was towed back to her wharf, and it is reported that only for her watertight compartments she would have sunk. On the Monarch the pumps were easily able to keep the water down, and subsequent repairs were not very extensive. The damage to both vessels was estimated at $40,000.

QUERIES AND ANSWERS.

Q.—In talking about modern high speed boats reference is often made to the horse power developed per ton of machinery. Is it not a fact that in some of the experimental flying machines as great, or greater, results were obtained in this direction as in any boat yet built? S. K.

A.—In a flying machine built by Hiram S. Maxim, the motive power was furnished by a compound engine with cylinders 5 in. and 8 in. by 12 in., which developed 300 horse power with 325 lbs. boiler pressure. The boiler was of the water-tube type with 600 tubes, 1-2 in. dia. and highly inflammable liquid fuel was used. The weight of the boiler and engine was about 1,900 pounds or about 6 1-2 pounds per horse power. In the 100 ft. experimental boat Turbinia the total of machinery weights was 22 tons, and as the engines developed considerably more than 2,000 horse power, this figures out about 22 pounds per horse power. These figures include, however, the weights of auxiliary engines and condenser, reversing turbine, and shafting and propellers, of which there were nine. In some of the later British torpedo-boat destroyers the weight figures out about 50 pounds per horse power by trial data. In the case of the torpedo boat destroyer No. 11, now building in this country, the estimated weights and power show approximately 43 pounds per horse power. An exact comparison cannot, of course, be made as the purposes of design and use are so dissimilar in vessels and flying machines, and again the weights given for the latter do not apparently include the mechanisms for operating the wings or vanes while in the case of the Turbinia the entire propelling apparatus is included.

Q.—Will you give me a rule for setting a spring loaded safety valve? R. S.

A.—Supposing the spring is made of square steel, multiply the pressure per sq. in. at which the valve is to lift, by the square of the diameter of the valve, by .02618, by the cube of the mean diameter of the spring, and by the number of coils in the spring, and divide the product by the fourth power of the thickness of the steel in sixteenths of an inch, the quotient will be the required amount of compression in inches. The mean diameter is measured across the coil from center to center of the steel, or in other words, is the outside diameter less the thickness of steel from which the spring is made. If the spring is made of round steel, substitute the constant .03454 for .02618 as above. Example: Take a 4 in. valve to lift at 100 pounds pressure with a spring 3 5-8 in. outside dia. and made of 11-16 in square steel, with seven coils. The square of the dia. is $4 \times 4 = 16$. The mean dia. of the spring is 3 5-8 — 11-16 = 2 15-16 = 2.9375 and the cube of this is $2.9375 \times 2.9375 \times 2.9375 = 26.973$. The number of coils is 7. The thickness of the steel in sixteenths is 11 and the fourth power of 11 is $11 \times 11 \times 11 \times 11 = 14,691$

Then: $$\frac{100 \times 16 \times .02618 \times 26.973 \times 7}{14,641} = .54$$

The spring will thus need to be compressed .54 in. As the elasticity of springs of the same dimensions varies, it is well to verify the rule by a practical test.

Q.—I would like to have a ready method of testing bituminous coal? RYAN.

A.—Place a grain of powdered coal in a platinum crucible, of known weight, heat to a temperature of 250 deg. F. until the coal is dried, when the weight will be constant. The moisture will be represented by the loss in weight. Now close the crucible containing the dried coal with a tight lid and apply heat gradually up to a bright red, using preferably a Bunsen burner. This will liberate the volatile hydrocarbons, and when this is accomplished cool off the crucible and again weigh it. The difference in weights will now give the amount of volatile matter. Now replace the crucible over the flame with the lid off and keep up the heat, so that the fixed carbon will be burned off. The ash will remain. Weigh this with the crucible and afterward the crucible alone and the difference will give the weight of ash. It will be necessary to use an accurate balance and also to conduct the experiment with care, as the quantity of coal is extremely small, and a slight error in the determination would mean misleading results when applied to large quantities. Great care should also be taken that the sample represents the average quality of the coal to be tested.

Q.—Why do high speed engines have a short stroke as compared with the diameter? F. B.

A.—Because they can be run at a high rotative speed without exceeding the limit of piston speed. A disadvantage of the type is the comparatively large proportion the clearance bears to the volume of piston displacement. An advantage is the high average temperature of the parts exposed to steam, causing less condensation wastes.

Q.—Can you give me a good way to clean a dirty dynamo? W. J. M.

A.—The dynamo should not have been allowed to get dirty. However, remove as much as possible of the dirt and grease from the armature and fields with a soft cloth. Then get a gasoline torch; fill it with benzine and, after pumping it up, spray the coils and follow quickly with a sponge cloth. Then apply a thin coat of shellac and leave the machine to dry before starting up.

Q.—Can you give me any rule for figuring the thickness of copper pipe necessary to withstand a given pressure? R.

A.—The rule adopted by the U. S. Government Supervising Inspectors, is to multiply the working steam pressure, in pounds per square inch, allowed on the boiler by the diameter of the pipe in inches, and divide the product by the constant whole number 8,000 and add .0625 to the quotient. This gives the required thickness in fractions of an inch. Thus to find the thickness of an 8 in. pipe connected to a boiler carrying 160 pounds of steam per sq. in.

$8 \times 160 = 1{,}280$

$8000 \overline{)\,12800\,(.16}$

8000

48000 $.16$

48000 $.0625$

$.2225$

which would be equivalent to No. 5 B. W. G.

Q.—Would there be any more economy in using steam at 100 pounds pressure and by expansion making the mean effective pressure 70 pounds, than in using steam of 70 pounds throughout the stroke? P. M.

A.—Suppose the volume of the cylinder to be one cubic foot, then by using an initial pressure of 70 pounds and continuing it throughout the stroke a cubic foot of 70 pound steam weighing .201 pound would be used at each stroke. By using 100 pound steam a mean effective pressure of 70 pounds would be got by cutting off at 3-8 stroke. As 100 pound steam weighs .264 pound per cubic foot, 3-8 cubic foot would weigh 3-8 of .264 = .099. Thus only .099 pound would be used at each stroke, cutting off as above as against .201 pound of the 70 pound steam. This is simply an explanation; in an actual case clearance would have to be considered to get accurate figures and then too in practice the actual gain would not equal the theoretical owing to the increased effect of cylinder condensation as the ratio of expansion increased.

Q.—What qualifications are necessary for enlistment as a machinist in the U. S. Navy? T. B. S.

A.—First that the applicant be a machinist by trade. This is the most important qualification. It is, of course, necessary too, that the applicant be in good physical condition and be possessed of sufficient education to understand drawings and measurements, and be able to do simple figuring. Application should be made in person at one of the receiving ships at Boston, League Island, or Norfolk, or in your case at the New York Navy Yard. An applicant under 21 years would have to show the consent of parents or guardians, but there is no maximum age limit fixed. The applicant would be examined practically by the Engineer Officers of the Navy and would have to pass the scrutiny of the Naval Surgeons.

Q.—Does the license of an engineer apply to the gross or net tonnage of a boat? N. Y.

A.—The gross. An engineer who holds a license for certain tonnage can serve in a vessel of a larger capacity, provided the engine in the larger vessel does not exceed in power that of the vessel for which his license was issued.

Q.—What was the date of the launch of the iron-clad Dunderberg, afterward the Rochambeau of the French Navy? A. T.

A.—She was launched July 22, 1865, from the yard of Webb & Roach on the East River.

Q.—What is meant by B. T. U? OILER.

A.—British Thermal Units. A unit of heat, or British thermal unit, is the amount of heat required to raise one pound of water (through one degree of temperature at its point of maximum density) from 39 to 40 deg. Fahrenheit.

An example of progressive practice comes from where it would be least expected—Spanish ownership. The steamer Riojano, formerly the Borderer, has recently been fitted with new machinery at Liverpool. She has now quadruple expansion engines, with a working pressure of 240 lbs. per sq. in., with forced draft. She is reported as having made a very successful trip.

To aid in making the British Royal Naval Reserve more effective, the Admiralty has established a course of instruction for engineer officers of the mercantile marine who are members of the reserve. This is located at Portsmouth, where there are great facilities for inspecting work during construction, attending trial and special trips, and viewing various types of engines and apparatus on board warships. The engineers attending the class receive the same pay that they would get on active service, and besides a lodging and provision allowance. The course lasts about three months.

Important Salvage Suit Decision.

A reduction of an award for salvage services from $27,500 to $16,666 was made in the U. S. Circuit Court of Appeals at Richmond, Va., recently, in the case of the British steamer Haxby. A libel had been filed by the Merritt Wrecking Organization of New York in the District Court for the Eastern District of Virginia, and Judge Hughes awarded the salvors $27,500. The owners had admitted the meritorious character of the service, but disputed the reasonableness of the amount claimed, and it is understood they offered to pay $15,000 before the commencement of the suit. They accordingly appealed, and the details, as given in the opinion of Circuit Judge Goff, are of interest.

The Haxby is a modern steel vessel fitted with triple expansion engines of 3,445 gross tons, 330 ft. long, 43 ft. beam and 21 ft. deep. She went ashore at night abreast of Dam Neck Life Saving Station, on the eastern shore of Virginia. Though drawing 12 to 15 ft. of water, she crossed a shoal over which there was only 6 ft. at low tide. She lay about 30 ft. from the beach at low water, and broadside on. The wrecking concern next day arrived with an outfit and got the Haxby off, towing her to Newport News. For this work they claimed $40,000. The value of the property they employed was about $117,000, and there was a crew of 24 men. The Court recognizes the skill displayed, but adds that the risk to life or property was only such as might be expected in such work. When the Haxby was delivered at dry dock she was badly damaged, and it was "clear from the evidence" that the injuries were received after the salvors commenced their work. At the time the vessel was delivered in dry dock her value did not exceed $100,000. Taking into consideration the courageous manner which the salvage work done and having regard to all the risks run, the Court decided that one-sixth of the value of the property saved would be fair to the salvors and just to the owners of the vessel. This amounted to $16,666, and an order was made remanding the case back to the Court below, with instructions to enter up the modified decree. This important case was argued by Robert M. Hughes, of Sharp & Hughes, Norfolk, Va., for the salvors, and by George Whitelock, of Schmucker & Whitelock, Baltimore, Md., for the owners of the Haxby.

The "Record of American and Foreign Shipping," just issued, is the thirtieth annual of the American Shipmasters' Society. Careful examination of this volume of reference shows that the compilers have done their exacting work with much care. It contains no preface, or other apology for its existence, and wisely so, as the work itself is its best recommendation and a reminder at all times to those who may consult it of its exceeding usefulness. In the 1898 edition 17,000 vessels, ranging from the infrequent ketch to the full-powered transatlantic liner, and flying the flag of every nation, are alphabetically arranged, with much detail as to build, ownership and condition. This information, of course, forms the bulk of the annual, but there are many other interesting sections. These include the Rules for the Construction and Classification of Vessels built under the inspection of the Association, also Rules for the Survey of Machinery and Boilers, and for the installation of electrical apparatus on shipboard. Also names of vessels which have been changed, and lists of compound names arranged alphabetically by the last word of the name for ready reference. Lists of the officers and representatives of the association at home and abroad are supplemented by an accurate list of the names and addresses of the representatives of Marine Underwriters throughout the world. Altogether it is truly an invaluable book of reference for those who go down to the sea in ships, and more particularly for those who wait ashore for them to reach port.

CATALOGUES.

The first calendar for 1898, and a neat one it is, is received from Robert A. Keasbey, 54 Warren street, New York. The heading is a basket of strawberries tipped over, natural in design and in the color of the berries.

In marine work tight joints are more necessary perhaps than anywhere else because of the difficulty in making repairs or securing duplicate parts. A little pamphlet on the subject is received giving a good deal of detail regarding the joints manufactured by the Tight Joint Co., 161 Bank street, New York.

Vulcabeston for steam and mechanical purposes has a catalogue devoted to it by the H. W. Johns Mfg. Co., 100 William street, New York. It is pocket size and contains a number of illustrations of washers, rings and gaskets, made from this material, together with an amount of descriptive matter, a list of sizes and some very strong testimonials.

Users of signal lamps will find it very useful to have on file a copy of the catalogue published by Russell & Watson, 145 Main St., Buffalo, N. Y. The catalogue describes this company's patent lens as applied to steamer and vessel signal lamps, also a full line of head lights, pier lamps, anchor and binnacle lamps, vessel torches and other marine supplies.

A Klondike puzzle is the holiday greeting which the Mason Regulator Co., 6 Oliver St., Boston, Mass., is distributing to its friends. It is very roundabout from Juneau to the heart of the Klondike, as every reader of Marine Engineering will find if he wishes to investigate the subject by sending for one of the puzzles.

Fore and aft compound engines manufactured by the Marine Iron Works, Station A, Chicago, are well illustrated in the folder issued regarding them. A full page drawing shows the detail of the engine and a large half tone illustrates the engine as set up and ready for use. These engines are made in various sizes and to suit all conditions. The detail of their design is told in the circular.

The business of shipping knockdown boats and launches as carried on by Fred Medart, boatbuilder, St. Louis, Mo., is illustrated in a folder just received. Every part of the boat is cut and fitted and the whole packed ready for shipping, so that the boats can be readily put together without difficulty. Amateur boatmen and others who are at all interested in the construction and building of boats will find this an interesting circular.

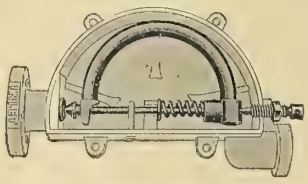
A new motor which will interest yachtsmen is being put on the market by the New York Compound Engine Co., 143 World Building, New York. The motor is an ammonia vapor launch engine, though the company also makes high speed steam engines. The catalogue just issued contains several illustrations of the ammonia motor and shows it installed in launches. A good deal of information is given, together with prices, weights, etc.

Tobin bronze is familiar to everybody connected with marine work, but few people can appreciate its qualities and many uses without studying the little catalogue, No. 181, issued by the Ansonia Brass & Copper Co., 19 Cliff street, New York. This catalogue is pocket size of 36 pages and contains very strong testimonials from some of the best known marine people in the United States. A copy of it should be in the hands of every man who has to do with such metals.

23 Years

in constant use — and no failures. Thousands of dollars saved by the "Heintz" Steam Trap. Simple — Durable — Efficient. Works in any position — discharges water to any height. No floats, no levers or delicate parts. Economizes fuel and labor — saves space — perfectly automatic—requires no watching. Money refunded if trap proves unsatisfactory within a year. Send for one on thirty days' trial free.

Booklet "G" for the asking, will show you how to save money.



William S. Haines Company,

136 South Fourth Street, Philadelphia.

"The Heintz—the best—tho' it has imitators."

21 COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y 11

LAMPS

For Every Purpose.

We make lamps for Yachts, Boats, Boathouses, Cabins, Wharves, Walks, or anywhere, indoors or out, where a good strong light is wanted.

Our goods need no recommendation from us. They are the standard. Other lamps are said to be "equal to," "like," or "as good as".

THE NEW ROCHESTER.

To be sure the lamps offered you possess the merits peculiar to the genuine, insist on seeing the name stamped in the metal. Catalog free. We give as much attention to making special lamps, repairs, etc., as to our regular line.

THE ROCHESTER LAMP CO.

42 Park Place and 37 Barclay St., New York.

Graphite Lubrication

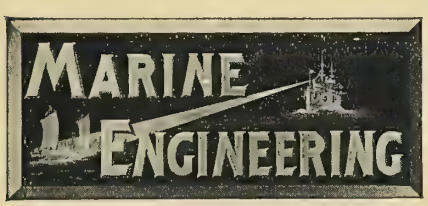
There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO.,
JERSEY CITY, N. J.

Bound Copies.

VOLUME I. APRIL-DECEMBER.



Price, $3.50 Delivered.

-:- Subscribers wishing back numbers
-:- to complete their files should order them at
-:- once as only a few copies remain of April,
-:- May and June.

MARINE PUBLISHING CO.,
WORLD BUILDING, NEW YORK.

The King marine gasoline engine is presented to the public in a very neat catalogue issued by the Charles B. King Co., Detroit, Mich. Unlike some catalogues of this nature, this one describes the mechanical features in such a way as to make the subject understood, giving such information as the user of an engine would most want to know. This company is also prepared to furnish launches of various types and sizes when called for, and they are illustrated in these pages.

A catalogue has been issued by John J. Tonkin, 609 Havemeyer Building, New York, descriptive of the Tonkin patent internally fired water-tube boiler. The general type of this boiler can readily be seen from the cut in the advertisement on the outside back cover of this magazine. Those wishing fuller details should send for a copy of the catalogue. Many features are of special value and some tests of unusual interest are given, together with a number of testimonials.

To supply the large demand for catalogues of its marine engines and launches the Daimler Motor Co., Steinway, Long Island, has issued a temporary catalogue of 42 pages, printed on coated paper, illustrating the various types of launches and boats, and also giving a good deal of detail regarding the motor. All the information one could ask for is contained within these pages, and every person interested should send for a copy. The launches and boats are of all sizes, from a 16 footer up to 85 ft. or 90 ft. or more.

A four page supplement catalogue is at hand from the Racine Yacht and Boat Works, Racine Junction, Wis. It contains pictures and drawings of a half dozen or more boats of various types manufactured by this company, from the small row and sail boat up to large cabin launches. Considerable space is given to the Midget, which is one of the special boats this company is pushing. A picture of this boat is shown in the advertisement on another page. The circular also contains picture and full description of the engine used in these small launches.

Pneumatic tools of the type shown in the advertisement of the Clement Pneumatic Tool Co., 125 South 11th St., Philadelphia, Pa., are fully described in a catalogue just received. These tools are extensively used in marine work for calking boilers, tanks and ships, for beading boiler tubes, for chipping, driving rivets and in many lines of submarine work. The several large illustrations in the catalogue tell very plainly the construction of the tools, and other illustrations show their operation. Copies of the catalogue can be had upon application to the company.

BUSINESS NOTES.

NEW LAUNCH FOR THE REVENUE SERVICE.—A handsome launch just supplied by the Government to the revenue cutter Bear for service in the Arctic Ocean and Bering Sea has a Forbes engine, supplied by W. D. Forbes & Co., Hoboken, N. J.

GOOD REFRIGERATION.—A gentleman just returned from London, where he investigated the subject of delivering meats and other cold storage stuffs to the English market, reports that the American line has the reputation of giving the best results, the temperature evidently being more uniform and under exact control. The American line steamers are all supplied with Kilbourn machines, manufactured by the Kilbourn Construction Co., Drexel Building, Philadelphia, Pa.

3-8 inch for Pipe Unions.

1-2 inch for Hand Holes.

In Boxes 3 to 5 lbs.

5-8 inch for Regular Size.

3-4 inch for Large Size Man Holes.

In Boxes 4 to 6 lbs.

Fac-Simile of a 6-inch Section of Eclipse Gasket Showing Name and Trade Mark Imbedded.

THE PEERLESS

Spiral Piston and Valve Rod PACKING.

Once Tried, Always Used.

Will Hold 400 lbs. Steam.

1-4 to 2 inch diameter.

Send for Catalogue.

20 YEARS OLD and NO EQUAL.

In Boxes 3 to 8 lbs.

Send for Testimonials.

BEWARE OF ALL IMITATIONS.

...They Will Not Do the Work...

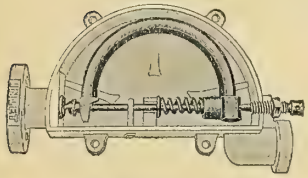
Manufactured, Patented and Copyrighted Exclusively by

PEERLESS RUBBER MFG. CO.,

16-24 Woodward Avenue, DETROIT, MICH. **16 Warren St., NEW YORK.** 202-210 South Water Street. CHICAGO, ILL.

$1,100

lost in three days because he wanted his old traps to wear out before he put in the "Heintz"—a mistake one man made, resulting in a bursting of the cylinder head. Other steam traps "wear out" with a suddenness that causes damage—the repairs cost more than would all the traps used in a lifetime. The "Heintz" is a perfect trap—never wears out—never, under any circumstances, allows the water to back up. It works under all conditions. Our Booklet "G" tells about it.



William S. Haines Company,

136 South Fourth Street, Philadelphia.

"The Heintz—the best—tho' it has imitators."

(c) COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 10

THE MASON REDUCING VALVE

FOR STEAM, WATER AND AIR.

Especially adapted for Marine Work in connection with heating, lighting and steam steering.

GIVES SATISFACTION WHEREVER USED.

Send for catalogue.

THE MASON REGULATOR CO.,

6 AND 8 OLIVER STREET,

BOSTON, MASS.

BOSTON & LOCKPORT BLOCK CO.,

BOSTON, MASS., U. S. A.

Manufacture everything in the Block, Sheave and Bushing line.

STAR

BRAND.

Send for free Catalogue of 112 pages, telling all about Blocks, etc.

Specify Catalogue T, and name this paper.

Registered Trade Mark.

TWISS MARINE ENGINES.—Nelson W. Twiss, New Haven, Conn., has recently sold a number of marine engines for use on boats in Long Island Sound and adjacent waters. These engines are designed to be rigid to make them capable of withstanding the hard usage frequently encountered on tugs, fishing vessels and other knockabout boats. They are made either simple, compound or triple-expansion. Small circulars have recently been issued illustrating these engines.

WHAT A WATER-TUBE BOILER GAINS.—The freight boat Clara, belonging to Charles L. Boyer & Sons, 90 Wall street, New York, is undergoing repairs for the purpose of making thorough tests of the Boyer water-tube boiler. The old boiler was of the return-tube type, using 100 lbs. pressure, having 28 1-2 ft. of grate surface, against 37 1-2 for the new boiler, 1,100 sq. ft. of heating surface, against 1,800 ft. to 1,900 ft. for the new one, and occupied a space 6 ft. by 11 ft., against 6 ft. 6 in. by 7 ft. 6 in. for the new boiler. Besides this reduction in space, the new steam plant will make a reduction of about 12 tons in weight.

A SATISFACTORY YACHT TENDER.—The following flattering letter explains itself: 817 Fifth avenue, New York, Nov. 24th, 1897. Marine Vapor Engine Co., Gentlemen:—I take great pleasure in adding this to the numerous testimonials which you have undoubtedly received endorsing your excellent motor. As far as my investigations go, it furnishes more power for its weight than any motor in the market. I found that I could carry, without inconvenience, in my 21 ft. launch for Calonia, a five horse power motor, from which I obtained surprisingly good results on several occasions when I found it necessary to tow my yacht. There are no unpleasant odors, and no excessive amount of noise. Very sincerely, C. A. Postley.

BIG CONTRACT FOR RIVER BOATS.—The contract for the construction of fourteen river steamers and twenty-four barges for the Yukon Co., of which Andrew F. Burleigh is president, has been secured by the Moran Bros. Co., of Seattle, Wash. Through an error, the ownership of these vessels was attributed to the Alaska-Yukon Co., in an article descriptive of the vessels building for the Klondike trade, on page 19 of our December issue. The Yukon Co. has headquarters in Seattle, and we understand that it will conduct most of the transportation business on the Yukon river during the coming year. The Moran Bros. Co. is to be congratulated on securing this extensive contract, which will give employment to a large force of men at their yards.

A FAST LAUNCH.—A launch has been built by the Spalding St. Lawrence Boat Co., Ogdensburg, N. Y., designed to be inexpensive, fast, and safe. The dimensions are: Length over all, 24 ft.; length on the water line, 23 ft. 6 in.; extreme beam, 4 ft. 8 in.; draft of hull, 8 in.; power, two H. P. Alco vapor motor, with a 17 in. wheel, 40 in. pitch. The engine is located about 6 ft. from the stern, and the oil tank the same distance from the bow, so that the center of fore and aft oscillation is short, and on account of the long decks at both ends, the boat is easy in a seaway. There are four water-tight bulkheads, so that there is no chance for the boat to be swamped, and in case of a hole in the bottom there is still sufficient air displacement to float. The lines are like the modern scientifically designed high speed yachts. The water line is very full aft, and the boat is entirely cut away underneath. The wheel is held on a bracket and a small fin, so that the center of axial resistance is far enough aft that the boat steers properly. Several speed tests were made on the St. Lawrence river over a surveyed mile, both with and against the current, and with a small sea, and the average was at the rate of 7.6 miles per hour. Several long runs were made, and from distances taken from the Government chart the average speed was 7 miles an hour against the current and 8 miles with it.

POPULAR STEAM DEVICES.—The four boilers of the S.S. Juniata illustrated in Marine Engineering for December were fitted with the Bloomsburg circulator and steam heating attachment, and one of the Bloomsburg jets was fitted in the donkey boiler stack. Bloomsburg circulators had previously been furnished for the "Gloucester" and also the "Howard," and jets for the donkey boiler stacks of the "Fairfax" and "Howard," sister ships. The Harlan & Hollingsworth Co. will make use of the circulators for the three boilers in the new yacht for Howard Gould, and Messrs. Bloomsburg & Co. have just delivered a jet for the 60 in. stack for the Norwich liner City of Lawrence. The contract for the Reading Railroad tug just closed with the Harlan & Hollingsworth Co. called for a Bloomsburg jet, being a duplicate of the one on the Reading tugs Catawissa and Tamaqua.

TO EXTINGUISH FIRES ON SHIPBOARD.—A new fire extinguisher for use on board vessels of all kinds is just being put on the market by the Underwriters' Fire Extinguisher Co., 2 Wall street, New York. The principle of the extinguisher is to generate dry carbonic gas by the proper combination of bi-carbonate of soda and sulphuric acid. The device is small and easily carried in the hand, and by simply reversing generates the gas, which can be injected into a fire by means of a hose and nozzle. Testimonials show that this gas will extinguish a small fire almost instantly. The enlarged principle as applied to steam vessels calls for thermostats in each coal bunker and in various parts of the holds, which actuate a central extinguisher connected to each center by means of pipes, so that in case of a blaze the device automatically operates itself and extinguishes the fire. We are informed the U. S. Navy has adopted the portable extinguisher for use on many war vessels.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

POSITION WANTED.

A marine engineer of 13 years' experience, licensed for a chief of 200 gross tons, or first assistant of 500 gross tons, desires position as engineer of a steam yacht or other vessel. Can take care of electric plant. Highest recommendation.
Address ENGINEER, care of MARINE ENGINEERING.

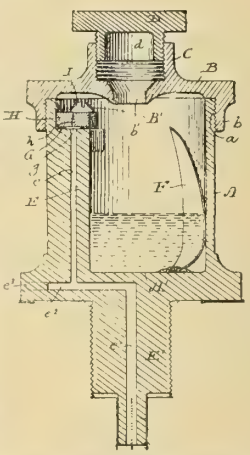
ENGINEERING CHEMISTRY.

Experienced analytical chemist would undertake investigations for engineers, or steamship companies.
Address CHEMIST, care MARINE ENGINEERING, World Building, New York.

WHEN CALKING
DECK SEAMS AND CHECKS IN RAILS, MASTS AND BOOMS,
USE ELASTIC SEAM COMPOSITION.
It is made in all colors and is positively guaranteed superior to any other seam preparation. It will not crack. When the wood expands it shrinks, and when the wood shrinks it expands. In use on steam yachts
SOVEREIGN, CORONET, ALMY, RESTLESS, VENTURE,
INTREPID, VALIANT, ELANOR, CLERMONT, BLACK PEARL,
and many other yachts and other vessels.
A. N. COLE, Foot of 24th St., BROOKLYN, N. Y.

BANGS AUTOMATIC
ROD AND ECCENTRIC CUP
FOR MARINE ENGINES.

It is a positive fact that about 90 per cent. of the oil generally put on engines is wasted. Do you know that the Bangs Automatic Oil Cup will save this waste? It is something worth thinking over.



The Bangs Cup is absolutely automatic; it will oil bearings thoroughly and uniformly; will will keep pins cool; reduce oil bills; it needs no special attention; will save its cost many times every month; will not feed when standing still; will lighten the labor of the oilers; will feed any kind of oil. It is exactly what we claim and what our testimonials prove it to be.

These Cups have been adopted by the American Line and the Red Star Line for all of their steamers.

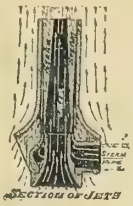
The James Reilly Repair and Supply Co.

229-230 WEST STREET, NEW YORK.
FOOT OF WASHINGTON AVE., PHILADELPHIA.

THE IMPROVED

ANNULAR STEAMJET

Most Powerful and Economical Known. Equal to Fan Blower. In use on Sound Steamer of 4,000 horse power, 2—8 ft. stacks. Cut on right shows section of Jets which attach to spider as shown on left. We are prepared to fill orders for any size stack, promptly.

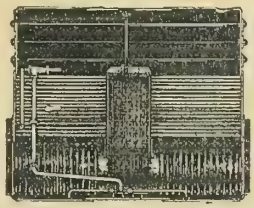


THE

EQUILIBRIUM CIRCULATOR

Circulates the Water in Steam Boilers. Increases Steaming Capacity. Equalizes Expansion. Prevents Foaming and Pitting. Prolongs Life of Boiler. Saves Cost of Repairs. Now in 55 Boilers.

H. BLOOMSBURG & CO.
818 Adams Street,
WILMINGTON, DEL.

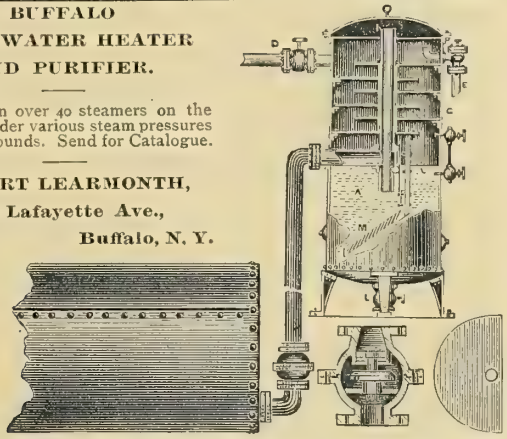


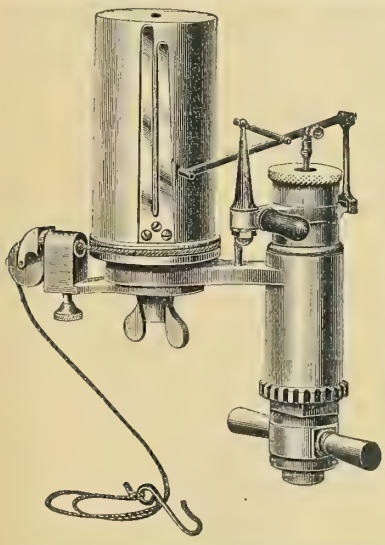
NEWPORT NEWS, VA.

BUFFALO
FEED WATER HEATER
AND PURIFIER.

In use on over 40 steamers on the lakes. Under various steam pressures up to 250 pounds. Send for Catalogue.

ROBERT LEARMONTH,
200 Lafayette Ave.,
Buffalo, N. Y.





AMERICAN THOMPSON IMPROVED INDICATOR.

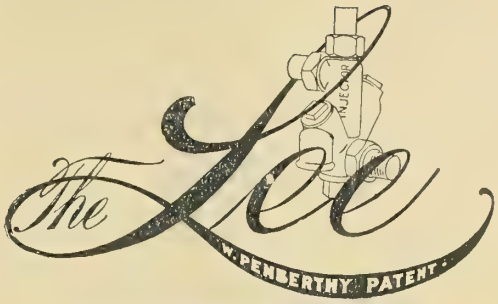
ORIGINAL THOMPSON INDICATOR.

Ideal Reducing Wheel, Pantograph and Planimeter.

BOURDON & LANE'S PRESSURE AND VACUUM GAUGES.

AMERICAN POP SAFETY VALVE.

AMERICAN STEAM GAUGE CO.,
34-36-38 Chardon St.,
Chicago BOSTON, MASS. New York
SEND FOR CATALOGUE F.



BALL VALVE AUTOMATIC

INJECTOR,

Especially Adapted for

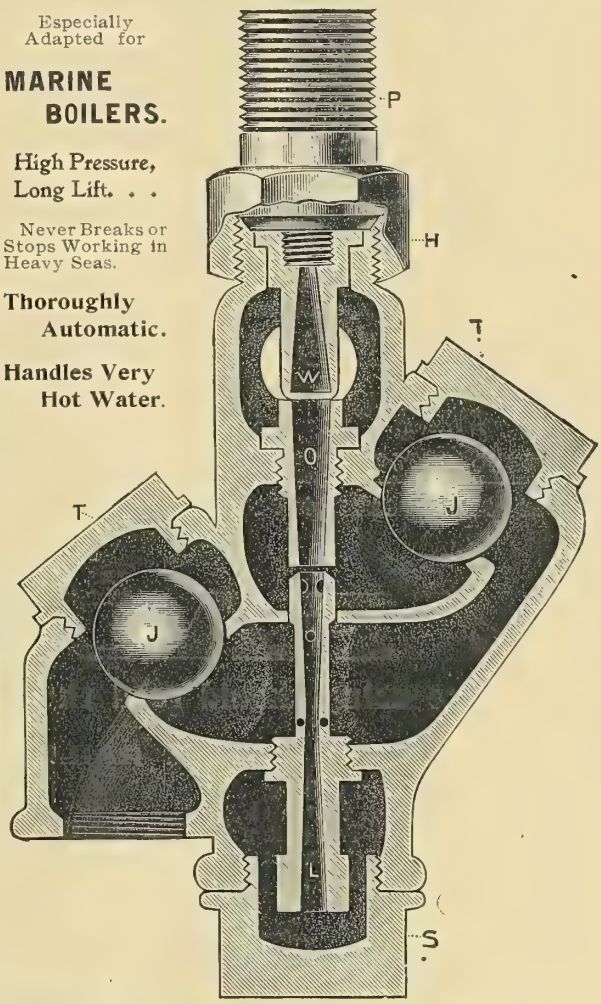
MARINE BOILERS.

High Pressure, Long Lift. . .

Never Breaks or Stops Working in Heavy Seas.

Thoroughly Automatic.

Handles Very Hot Water.



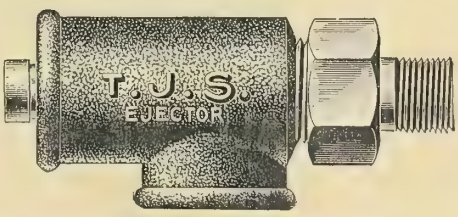
Pump Out the Bilge Water,

Wash Down Your Decks.

Use T.J.S. for Economy,

For Cleanliness,

For Convenience.



SEND FOR ILLUSTRATED CATALOGUE.

LEE-PENBERTHY MFG. CO.,
Nos. 101-103 Abbott Street, DETROIT, MICH.

IMPERIAL SPIRAL...

PACKING For Pistons And Valve Rods.

This packing consists of a round red rubber core, wrapped with specially woven duck, thoroughly coated and lubricated with the finest quality of plumbago, entirely free from grit. It will keep stuffing boxes tight with the least possible friction, and being very durable, it is an ideal packing for marine service. Any size from ¼ in. to 2 in. Write for sample.

Manufactured by

BOSTON BELTING CO.

JAMES BENNETT FORSYTH,
Mfg. Agt. and Gen. Mgr.

The Highest Grades of Hose, Packing, Gaskets, Valves.

BOSTON: 256-260 Devonshire St. NEW YORK: 100 Reade St. CLEVELAND: 150 Water St.
SAN FRANCISCO: 24 Fremont St. NEW ORLEANS: 316-318 St. Charles St.

RANDOLPH BRANDT,

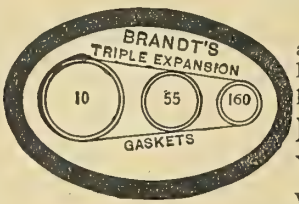
38 Cortlandt Street, New York.

SPECIALTIES.

SELDEN'S PATENT PACKINGS

are made either with a rubber core or a canvas core and will keep stuffing boxes tight with less friction than any other packing.

BRANDT'S TRIPLE EXPANSION GASKETS



are the best man-hole and hand-hole gaskets for high pressures.

BRANDT'S PUMP VALVES will stand hot water and oils.

The best grades of **Rubber Hose, Joint Packings** and other **Engineers' Stores.**

Orders filled promptly and satisfaction guaranteed. Your trade is solicited.

Engineers who are dissatisfied with the

PACKING

they are using should read the following letter:

ERIE RAILROAD COMPANY.

JAMES L. ROBERTSON & SONS, No. 204 Fulton St., N. Y.

JERSEY CITY, N. J., Sept. 20, 1897.

DEAR SIRS:—The Fulton Flexible Metallic Packing you furnished us nearly three years ago, and which is still in use, has been so satisfactory we have just put in a requisition for more.

Yours truly,
E. DUBOIS,
Chief Engr. Floating Equipment.

SHALL WE SEND YOU A FREE SAMPLE?

...If You are Interested in Indicators...

You can't afford to be without our Catalogue. Send for one.

JAS. L. ROBERTSON & SONS,

204 FULTON ST., N. Y. 12 PEARL ST., BOSTON.

20,000 Locomotives

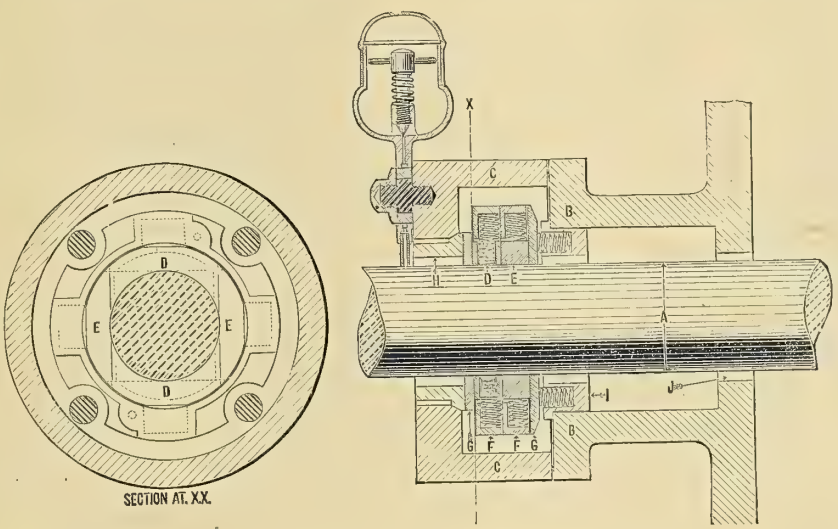
and

Thousands of

Marine and Stationary

.. Engines ..

Are Packed with our Packing.



IT IS THE **CHEAPEST**

AS WELL AS **THE BEST**

PACKING.

SEND FOR CATALOGUE.

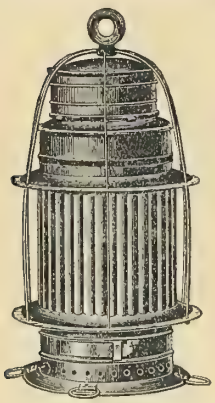
U. S. METALLIC PACKING CO.

429 North Thirteenth Street, PHILADELPHIA, PA.

WM. PORTER'S SONS, Manufacturers of

Oiland Electric Marine Lamps, Signals, Fixtures, Etc.

271 PEARL ST., - - NEW YORK.



Last month it was an
Anchor Lamp.
Here is another *Safety*—
not *Danger*—signal.

OUR PATENT FLUTED LENS SIDE LIGHT.

Colors perfect; light can be seen for 10 miles. Why use poor lamps and risk collision? Send for our catalogue and save your ship.

Everything in Marine Lamps.

Russell & Watson, 145 Main St., Buffalo, N. Y.

We Manufacture a Complete Line of

BRASS SIDELIGHTS.

ALSO

THE "CORRECT" AUTOMATIC STEAM FLUE CLEANER.

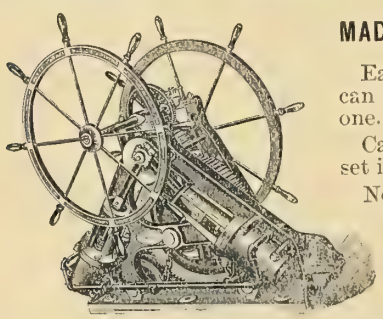
WRITE FOR TERMS.

VIADUCT BRASS WORKS,

34 Center Street, CLEVELAND, OHIO.

CHAS. A. CLAFLIN, Eastern Agent,
235 Franklin Street, Boston, Mass.

SHERIFFS STEAM STEERER.



MADE IN TWO SIZES.

Easy to adjust, and can be handled by any one.

Can be arranged to set in pilot house or aft.

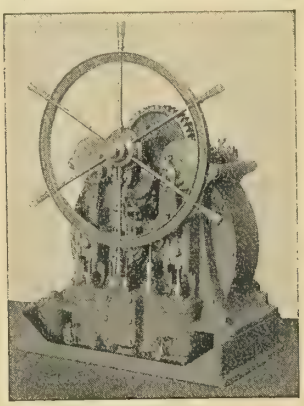
No Steerer will be sold without a quadrant.

Steerer will be sold on approval.

SHERIFFS MFG. CO.,

126-130 Barclay Street, - - MILWAUKEE, WIS.

BECK'S PATENT STEERING GEAR.



Steam and Hand.
Built in all Sizes.
Simplest, Strongest, Most Reliable.
Changed from Steam to Hand or back by One Lever in less than One Second.

Built by
PAWLING & HARNISCHFEGER,
Milwaukee, Wis.

More than 7 Steamship Lines equipped with Refrigerating Machinery.

KILBOURN

935 Drexel Bldg., Philadelphia.

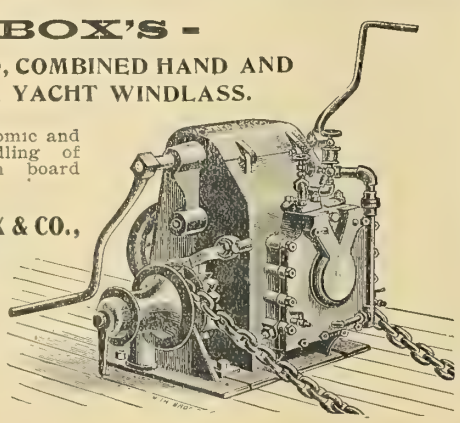
Our Machine for **YACHTS** requires 5 ft. square only.

BINDERS for MARINE ENGINEERING Handsomely Bound in Cloth, BY MAIL, 75c.

- BOX'S -

IMPROVED, COMBINED HAND AND STEAM YACHT WINDLASS.

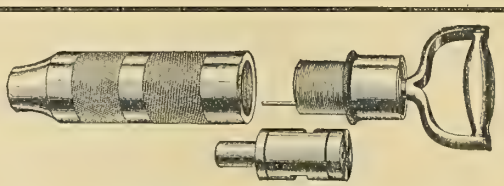
For the Economic and Rapid Handling of Anchors on board Yachts.



ALFRED BOX & CO.,

Front, Poplar & Canal Sts.,

Philadelphia, Pa.



It has only three parts. Cannot get out of order. We Guarantee it for two years.

THE CLEMENT PNEUMATIC TOOL COMPANY,

123-125 South Eleventh St., PHILADELPHIA, PA.

PNEUMATIC TOOLS

and Appliances for Chipping and Caulking Boilers and Ships.

REFERENCE:—Wm. Cramp & Sons, Ship and Engine Building Co., Philadelphia, Pa.

Catalogue on Application.

COLE'S PRESERVER OF MARINE BOILERS

....For the Removal and Prevention of Scale and Corrosion....

It effectually prevents foaming, likewise galvanic action where the feed water is condensed and comes in contact with copper, brass or galvanized iron.

A. N. COLE, CHEMIST,
Foot of 24th Street, BROOKLYN, N. Y.

THOS. C. WARLEY & CO., *Manufacturers of*

BOILER CLEANSING COMPOUNDS

Main Office: No. Eleven So. Ninth St., Philadelphia, Pa.
P. O. BOX 1262.

These Compounds are unequalled. They give satisfaction where others fail. They are especially adapted for use in Marine Steam Plants. WRITE FOR DESCRIPTIVE CIRCULAR.

L. J. WING & COMPANY,

MANUFACTURERS OF

Wing's Marine Gas Engines

FOR YACHTS, LAUNCHES AND BUSINESS BOATS.

Auxiliary Power for Sailing Vessels.
Stationary Gas Engines and Motors for Horseless Wagons.
The Safest, Smallest and Most Reliable Engine Made.

YACHTS, LAUNCHES AND BOATS OF ALL KINDS BUILT, BOUGHT, SOLD OR CHARTERED.
WING'S DISC FANS, ELECTRIC LIGHTING, ETC.

109 LIBERTY STREET, - NEW YORK.

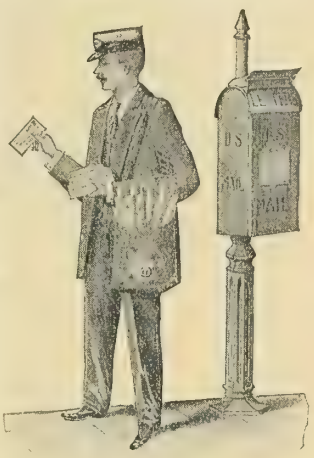
STEAM ENGINEERING

(Stationary, Locomotive, Marine); Mechanical Drawing; Architectural Drawing; Machine Design; Electricity; Architecture; Plumbing; Railroad, Municipal, **31 COURSES** Hydraulic & Bridge Engineering; Surveying and Mapping; Metal Pattern Cutting; Bookkeeping; Shorthand; English Branches; Mining; Metal Prospect'g.

All who study **GUARANTEED SUCCESS.**
Fees Moderate, Advance or Installments.
Circular Free; State subject you wish to study.
International Correspondence Schools, Box 1111, Scranton, Pa.

"A College Education by Mail."

MARINE ENGINEERING TAUGHT BY MAIL.



Officers, Engineers, Firemen, Sailors, and Helpers should employ their leisure hours at home or on board ship profitably by enrolling as students in *The Schools of Engineering*, including **The Home Schools of Mechanical Engineering, Electrical Engineering, Steam Engineering, Civil Engineering, and Sanitary Engineering.**

Our **Instruction and Question Papers** can be sent to you in advance of your arrival at any port, and we can keep you constantly supplied with new material to study.

Our instruction is *thorough* and *practical*, and fits the *Fireman* for the position of *Engineer*, prepares the *2d Grade Engineer* to pass his examination for *1st Grade Engineer;* it teaches *the officers* the rules of the road, and keeps *the captain* informed of the latest improvements in Marine Engineering.

Mechanical Drawing is taught by our improved and well-tried method. Every student learns to make thoroughly practical and complete working drawings.

The instruction is **confidential**, and you can **enroll at any time.** The requirements for admission are a knowledge of reading and writing.

Our fees are very moderate, payable either *in advance* or *in installments, in amounts to suit each student.*

To all enrolling before February 1st, 1898, we will give a **Complete Drawing Outfit costing $11.10, free.**

We guarantee to teach each student until he has passed a satisfactory examination in each subject in the course, even if it takes him five years or more to finish it.

Write for our large, illustrated Circular W, and state in what subject you are interested. This Circular sent free on application, and contains list of courses, sample pages of the Instruction and Question Papers, and a Sample Drawing Plate.

THE UNITED CORRESPONDENCE SCHOOLS,
154, 156, 158 FIFTH AVENUE, NEW YORK.

F. W. EWALD, General Manager.

THE CHICAGO NAUTICAL SCHOOL,

20 MICHIGAN AVENUE, CHICAGO, ILL.

W. J. WILSON, PRINCIPAL.

A FULL AND COMPLETE COURSE OF INSTRUCTION IN LAKE AND OCEAN NAVIGATION.

FIRST COURSE—The Arithmetic of Navigation; The Compass and its Details; Variation and Deviation of a Compass; Different Methods of Determining Same; Compass Adjustment; The Subject of Time, Declination, Etc.; Charts and Chart Construction; Plotting Position by Bearings; Weatherology; Law of Storms.

SECOND COURSE—Dead Reckoning; Middle Latitude and Mercator's Sailing; Great Circle Sailing; Latitude by Meridian Altitude; Longitude by a Chronometer Sight of the Sun; Danger Angles and Other Advanced Chart Problems; Latitude by the Pole Star; Sumner's Method; Use and Adjustments of the Various Instruments Employed.

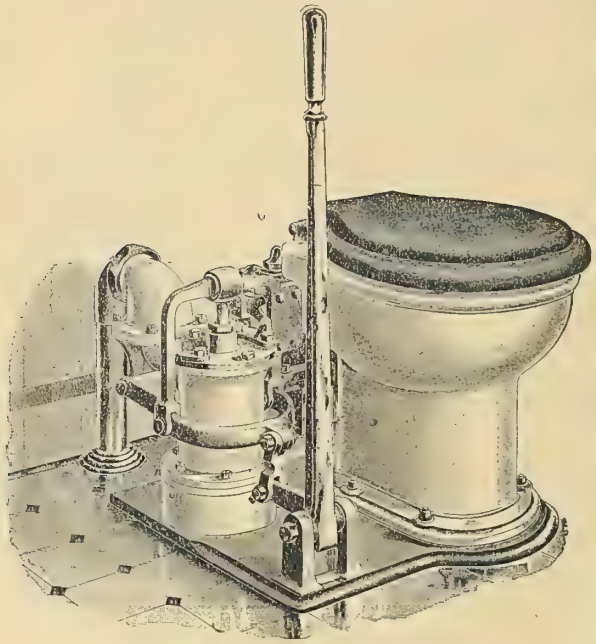
THIRD COURSE—A full and complete course in the Higher Branches of Mathematics pertaining to Navigation, Nautical Astronomy, Use and Correction of Instruments, Marine Laws, Customs Laws, Etc., Preparation of Papers and Documents, Etc., is in course of preparation.

SPECIAL STUDIES—Those who are already engaged in navigation, and desire to fit themselves for better positions in the service, can do so by special arrangement.

HOWELL'S PATENT

MARINE PUMP WATER CLOSET

THE "NEPTUNE"



ONE LEVER DOES THE WORK.

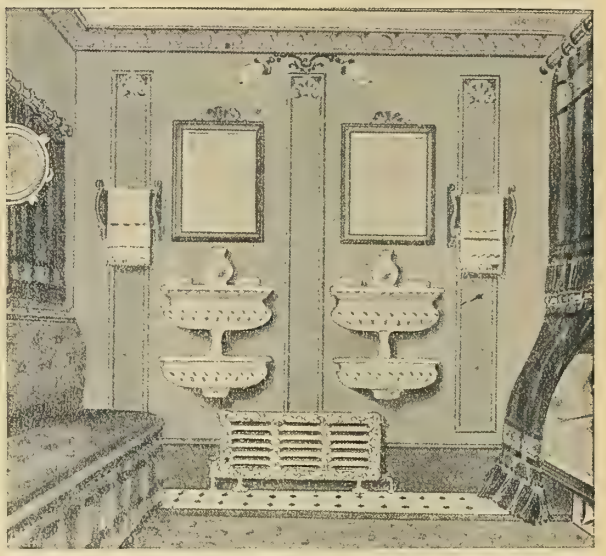
Circulars giving full information furnished upon application.

McCAMBRIDGE & CO., Ltd.,

523, 525 & 527 Cherry Street, PHILA., PA., U. S. A.

FOWLER & WOLFE

Steamship Radiators.



Sections may be combined in a variety of forms to make any sized Radiator. Designed to withstand high pressures. Can be furnished copper-electroplated when desired, to resist corrosion. Occupies less space and is more efficient than any Radiator made.

FOWLER & WOLFE MFG. CO.

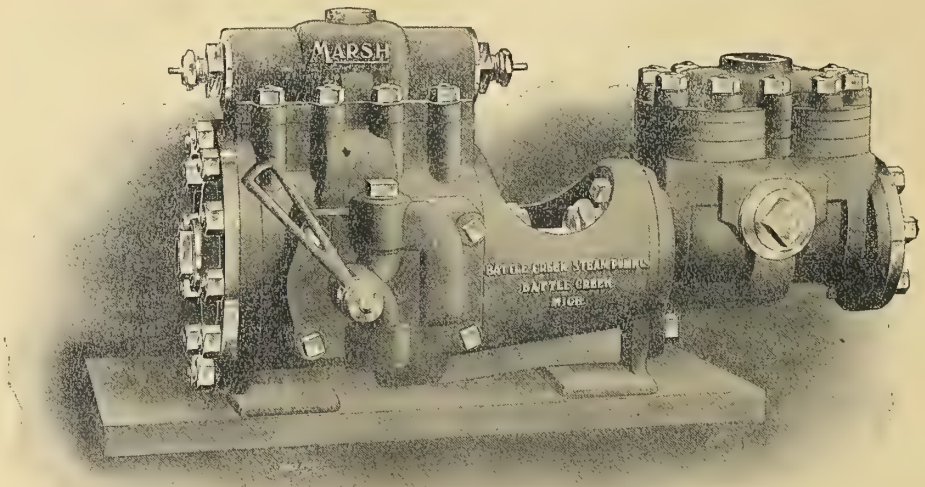
GENERAL OFFICE, BOURSE BUILDING,

PHILADELPHIA, PA.

SEND FOR ILLUSTRATED CATALOGUE.

BATTLE CREEK STEAM PUMP CO.,

Marsh Yacht Pump.



Catalogue or other information will be sent on application.

NOTE: Two Marsh Yacht Pumps on the "Ellide," the fastest yacht in the world.

JAPAN ...PAINTS

Have no Equal for

BRILLIANCY,
GLOSSINESS,
DURABILITY.

...ALL COLORS...

Where applied the surface becomes coated as with glass, resisting the influence of weather, water (fresh or salt), and keeps its gloss for years.

The American Greyhounds and other crack Ocean Steamers, and numerous Yachts and Ferry Boats are painted with it.

For all kinds of House Painting (Indoors and Outdoors), Railroad, Tramcars, Wagons and all kinds of Iron Structures and Machinery; in fact, everywhere and everything where you want something

...BEAUTIFUL AND LASTING...

EDWARD A. BUNKER, Sole Agent,
27 and 29 William St., - - NEW YORK.

12,000 in Use.

Unaffected by Weather. Portable, Self Contained.

800 to 4000
CANDLE POWER FROM
KEROSENE OIL.

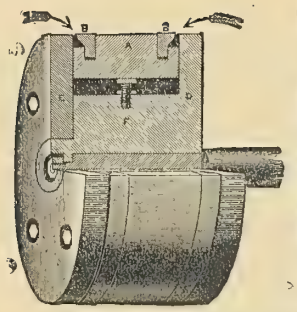
Especially adapted for Contractors, Quarries, Shovels, Railroad Construction, Dredges, Bridge and Dock Builders, Water Works, Brick Yarks and Coal Docks.

400 RAILROADS and over 500 CONTRACTORS NOW USE THE WELLS LIGHT.

THE WELLS LIGHT MFG. CO.,
EDWARD ROBINSON, Sole Proprietor. 46 Washington St., New York.

B&O
BEST LINE
Solid Trains
TO
Eastern Cities
STOP OVER
AT
WASHINGTON

The acme of typewriter construction is attained in
REMINGTON STANDARD TYPEWRITER
The Standard Remington Typewriter
NEW MODELS
Nos 6 AND 7



SELF-ADJUSTING STEAM CYLINDER PACKING

for **STEAMSHIP, YACHT, TUGBOAT,** and all classes of **ENGINES,** high and low pressure.

Makes piston perfectly tight with minimum of friction. Increases revolutions of wheel, saves fuel, secures true cylinder. Owing to its immediate action, engines can be started, stopped, or reversed instantly. Used in the engines of the leading Steam Yachts and Vessels.

We guarantee no leakage of Steam over piston.

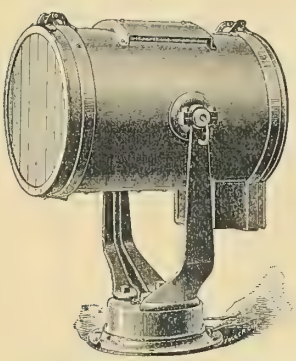
Manufactured and licenses granted to manufacture under our patents by

THE ST. JOHN CYLINDER PACKING CO.

General Offices: 108 Fulton Street, N. Y. City, N. Y.

SHELDON H. BASSETT, Gen'l Agt.

Electric Search Lights



FROM

1,000 to 10,000 Candle Power

ADAPTED TO

Lake & Marine Vessels,

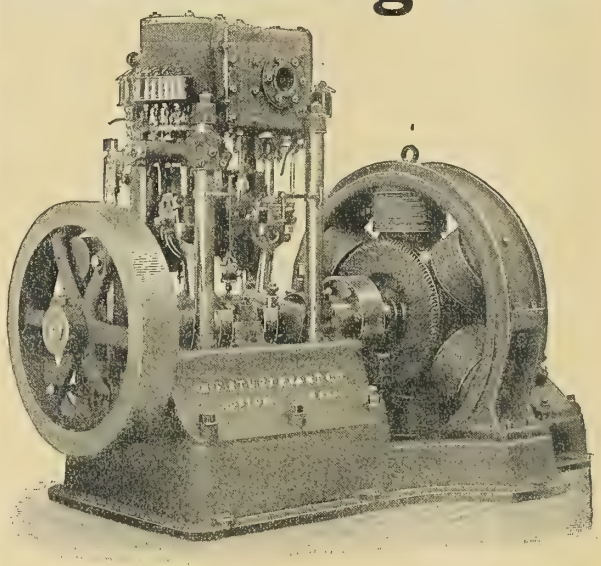
ALSO TO

Launches and Yachts.

SEND FOR CATALOGUE "A."

The Carlisle & Finch Co.,
834 W. 6th STREET,
CINCINNATI, OHIO.

STURTEVANT Generating Sets



SIZES UP TO 65 K. W.

Send for Catalogue.

B. F. STURTEVANT CO.

Works: Boston, Mass., U. S. A.

BOSTON. NEW YORK. CHICAGO. PHILADELPHIA. LONDON. GLASGOW. BERLIN. STOCKHOLM.

A man with a boat

to construct must pay heed to the character of the electrical installation—it's vital—it's essential to safety. A good installation can only be secured by the use of time-tried confidence imparting material. A vulnerable point is the wire—we sell

Okonite Wire.

It's the standard. Electric currents have tried for years to get through Okonite insulation, but it can't be done.

We also have full lines of all kinds of standard material for marine electric work.

OKONITE
TRADE MARK.

CENTRAL ELECTRIC CO.,

173-175 Adams Street,

CHICAGO.

GEO. A. McKINLOCK, Pres't.
CHARLES E. BROWN, Sec'y.
S. R. FRAZIER, Treas.

SEE HYDRO-PNEUMATIC
Ash Ejector.

AVOIDS DUST AND NOISE. SAVES COAL. LIGHTENS LABOR. PREVENTS INJURY TO PAINT. MORE THAN 300 NOW FITTED AND ORDERED.

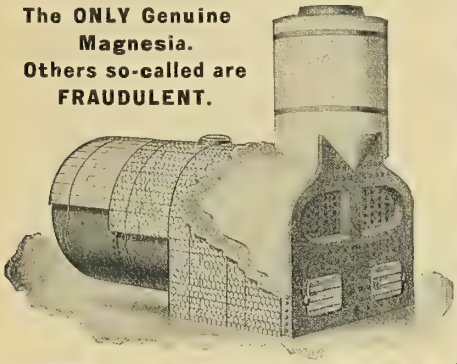
PATENTED IN THE UNITED STATES AND ABROAD.

In order to avoid infringement apply to the sole manufacturer under the patents,

HORACE SEE, No. 1 Broadway, New York.

MAGNESIA SECTIONAL COVERING

The ONLY Genuine Magnesia. Others so-called are FRAUDULENT.



Over 85% Carb. of Magnesium

USED ON

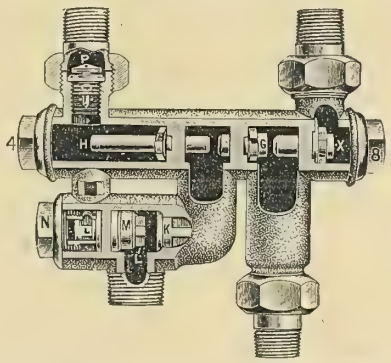
Nine-tenths of the U.S. Government vessels.

More High-Class Yachts than All Other Coverings Combined.

All leading S. S., S. B., Towing and Dredging Lines, etc. Send for References, Tests, Prices, etc., etc., to

13 TERRACE, BUFFALO. ROBERT A. KEASBEY, 54 WARREN STREET, NEW YORK.

THE
PENBERTHY
Special Auto-Positive



INJECTOR.

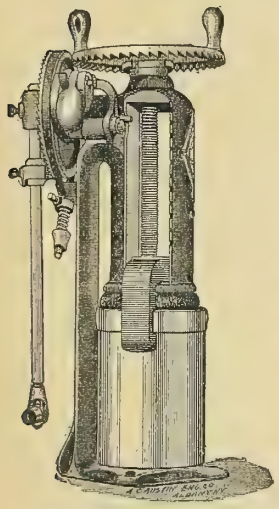
Working Range, 15—250 lbs. steam. Handles Hot Water up to 145 degrees.

SEND FOR DESCRIPTIVE CIRCULAR.

PENBERTHY INJECTOR CO.,
115 Seventh St., Detroit, Mich.
BRANCH FACTORY, WINDSOR, ONT.

...Largest Injector Manufacturers in the World...

National Automatic Lubricator, Patented.

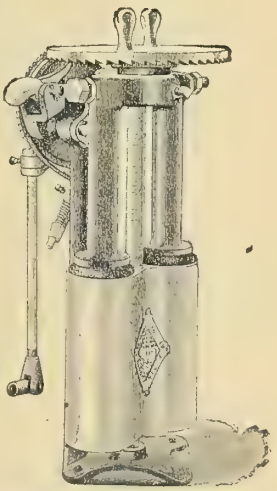


AN ABSOLUTE FORCED FEED.

Positive, Reliable, Economical, Satisfactory.

Guaranteed to save 30 to 60 per cent of oil and give better results to frictional parts. Not affected by change of temperature or consistency of oil.

If you are thinking of getting a New Engine or Pump, specify this Lubricator. It will be money in your pocket.



WRITE FOR CATALOGUE OF LUBRICATORS AND SIGHT FEED ATTACHMENTS.

National Lubricator Co.,

BUFFALO, SHERWOOD MFG. CO. ALBANY, N. Y.

KINGSFORD BOILER WORKS, *OSWEGO, N. Y.*

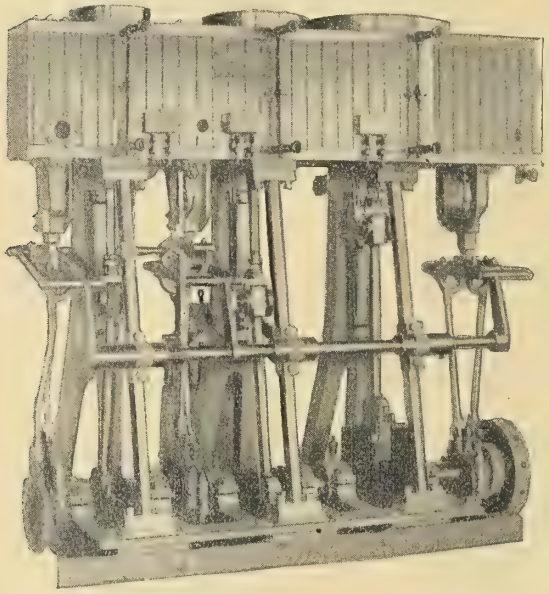
Marine Boilers of every description designed and constructed on short notice. Estimates given.

Best Material.
High Class Workmanship.
Reasonable Prices.

Special Types of Marine Boilers for Steam Yachts, Passenger Steamers, and Tugs.

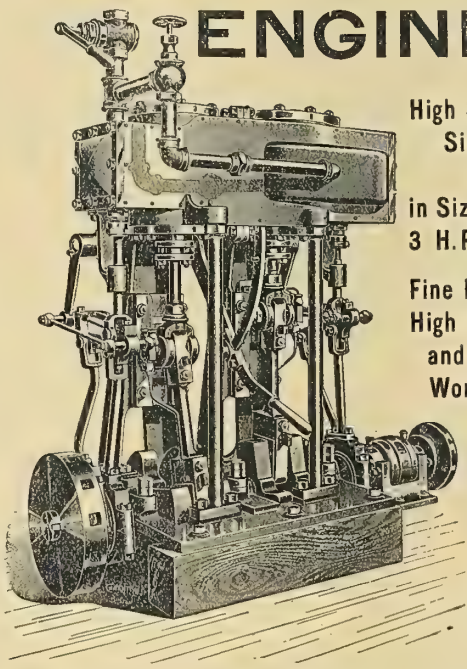
Kingsford Foundry and Machine Works,
OSWEGO, N. Y.

Marine Engines
AND MACHINERY FOR YACHTS, PASSENGER BOATS AND TUGS.
Also makers of the well known
= = = PAINE PROPELLER WHEEL. = = =



Long Distance Telephone. Your Inquiries Solicited.
JAMES H. PAINE & SON,
Cor. Clayton and Park Sts., BOSTON, MASS.

MARINE ENGINES,



High Speed, Single and Compound, in Sizes from 3 H.P. upwards.

Fine Design, High Finish and First-class Workmanship.

Large Accessible Bearings with Automatic Lubrication. Light but Strong Construction.

Moderate Prices.

Write for Circulars.

MORRIS MACHINE WORKS,
BALDWINSVILLE, NEW YORK.
New York Office, 39 & 41 Cortlandt Street

ALMY WATER-TUBE BOILER CO.

MANUFACTURERS OF

Almy's Patent Sectional Water-Tube Boilers

For Marine and Stationary Work,

NOS. 178 TO 184 ALLENS AVENUE (between Rhodes and Public Streets),

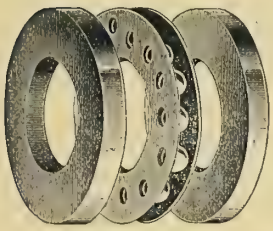
TAKE EDDY ST. CAR.
LONG DISTANCE TELEPHONE.

Providence, R. I.

BALL THRUST COLLARS

...FOR...

PROPELLER SHAFTS.



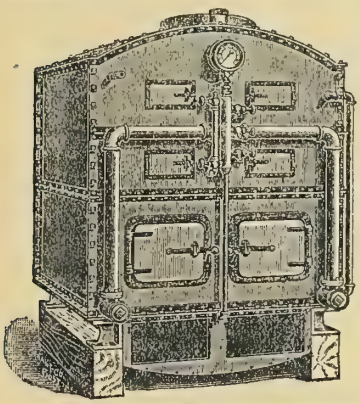
THEY CANNOT HEAT. *HUNDREDS HAVE*
THEY SAVE POWER. *BEEN APPLIED BY*
THEY ARE DURABLE. *LEADING BOAT BUILDERS.*

THE BALL BEARING CO.,

WRITE FOR CATALOGUE. 7 WATSON STREET, BOSTON, MASS.

New York Office: American Tract Society Building.

...CLARK'S PATENT SAFETY WATER TUBE BOILER...



—FOR—

MARINE AND STATIONARY ...WORK...

NOW USED IN A NUMBER OF YACHTS, LAUNCHES AND PASSENGER STEAMERS.

Manufactured by

EDWARD S. CLARK,

Nos 272-278 Freeport St.,

Harrison Sq.,

BOSTON, MASS.

MARINE

ENGINES

Simple, Compound and Triple.

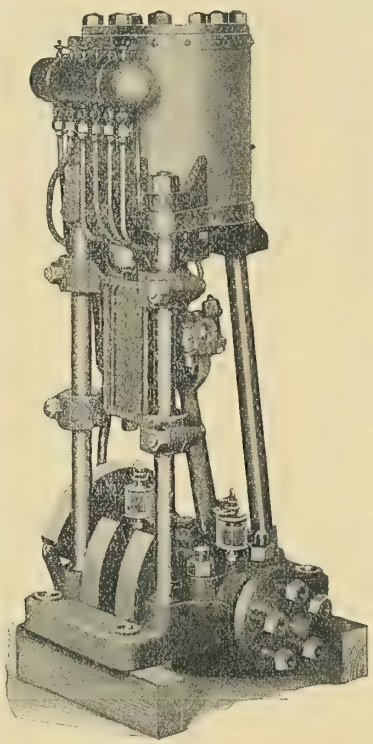
ALSO

FIRST-CLASS REPAIR WORK

Promptly and Thoroughly Done.

CHARLES L. KING, Brooklyn,

Foot of 55th Street.



THE FORBES ENGINE.

TAKE NOTICE OF THE FOLLOWING:

1st. COLUMN DESIGN. Extreme accessibility, with no loss of strength.

2d. CAREFUL BALANCING of steam and reciprocating parts.

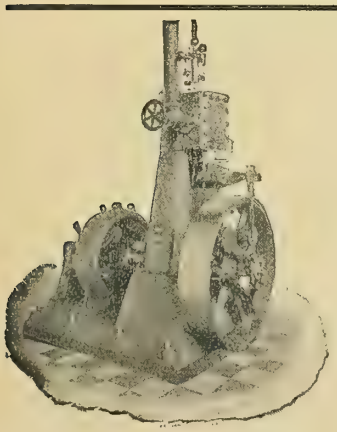
3d. OIL TANK. Giving perfect distribution, essential at high speed.

Telephone Call 36.

W. D. Forbes & Co.,

60 13th Street, Hoboken, N. J.

2 Blocks from 14th St. Ferry.



"Shepherd" ENGINES.

MARINE, for Yachts, Tugs, Steamers and Ferries.

STATIONARY AUTOMATIC, for lighting and power.

DAVIS-FARRAR CO., Erie, Pa.

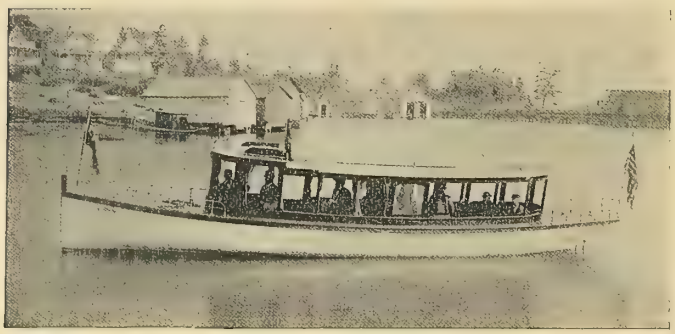
ALCO VAPOR

Hunting Launch.

Sportsman's Floating Camp. Motor controlled from bow. Valve movement, 12 to 1. 16 to 60 ft. Launches. Twin Screws a specialty. 1, 2, 3, 5, 7, and 12 h. p. No licensed engineer or pilot required. Speed and Safety guaranteed. **No dangerous Naphtha or Gasoline used.** No disagreeable vibration. SEND TEN CENTS IN STAMPS FOR 1897 CATALOGUE.

MARINE VAPOR ENGINE CO., Foot Jersey Ave., Jersey City, N. J.

WHY IS THE SINTZ MARINE ENGINE THE BEST?



Because it gives more actual power for the cost of running than any engine on the market. It occupies less space and weighs less per horse power. It does not require a flame to ignite the charge. It is absolutely safe. It is practically free from all valves, and has less than one-half as many parts as any other engine, and only three moving parts. It is clean—no dust, no dirt, no offensive odor and nothing to soil the clothes. It only requires half a minute to start, and runs equally as well in cold weather as in warm. It requires no government inspection, no licensed engineer or pilot.

The best boat builders use these engines because they please their customers and sell themselves. Ask your boat builder, or write to us for catalogue.

The Sintz Gas Engine Co.,

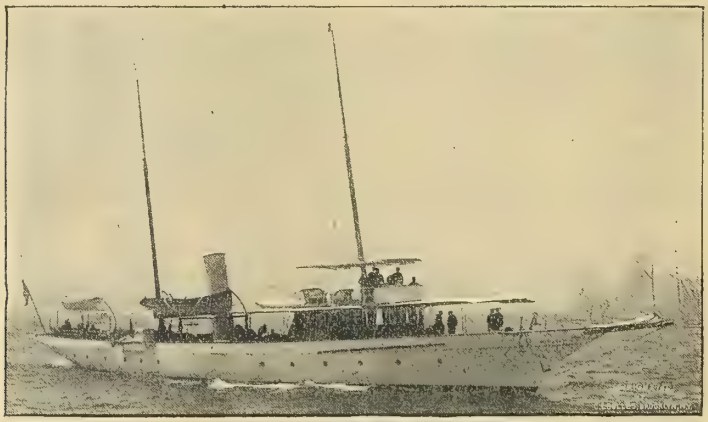
GRAND RAPIDS, MICH.

Write for Catalogue.

STEAM YACHTS.

THE ONLY NAPHTHA LAUNCH.

MARINE ENGINES.



SEABURY'S WATER TUBE BOILERS.

Reliable, Safe, Durable, and Compact. Light in Weight, Easy to Manage. Suitable for Marine or Stationary Work.

Sail Yachts and Yacht Tenders.

SEND 10c. STAMP FOR CATALOGUE OF STEAM AND NAPHTHA.

GAS ENGINE & POWER CO. and
CHARLES L. SEABURY & CO., Consolidated,
Morris Heights, New York City.

TEBO'S YACHT BASIN COALING STATION AND FLOATING DRY DOCKS, FOOT 23D ST. BROOKLYN.

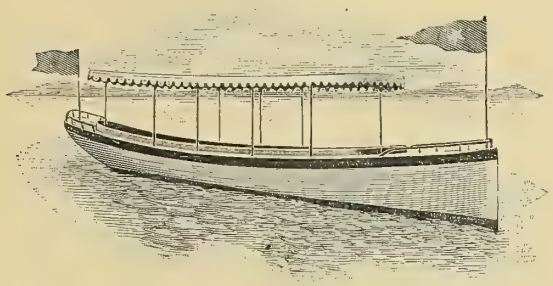
BROOKLYN FLOATING DOCK AND SHIPYARD.

THEO. A. CRANE'S SONS, - - - PROPRIETORS,
Erie Basin, South Brooklyn.
CAPACITY OF DOCK, 1200 TONS. LENGTH OF KEEL BLOCKS, 200 FT. Telephone, 236 Hamilton.

W. & A. Fletcher Co., North River Iron Works,
HOBOKEN, N. J.

MARINE ENGINES, BOILERS, ETC.

FLOATING DERRICK. - - - - - - AMPLE WHARF.



Yachts, Launches, Marine Machinery
OF EVERY DESCRIPTION.

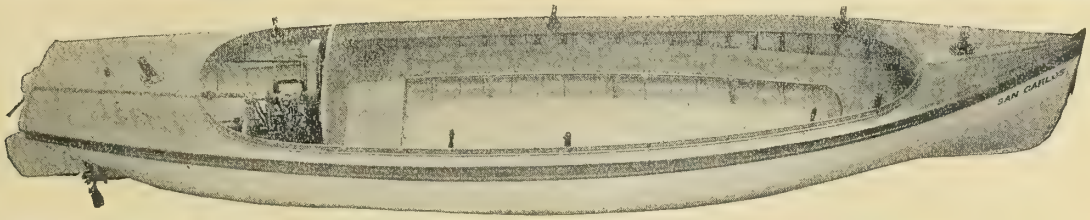
We build complete
GASOLINE and STEAM POWER PLANTS.
Our Gasoline Launches are in use by the Lighthouse Service.

We have no SECOND GRADES in HULLS or MACHINERY, as we build nothing but the BEST.

SEND SIX CENTS IN STAMPS FOR CATALOGUE.

THE POWER AND LAUNCH CO., BRIDGEPORT, CONN.

LAUNCHES. LAUNCHES.



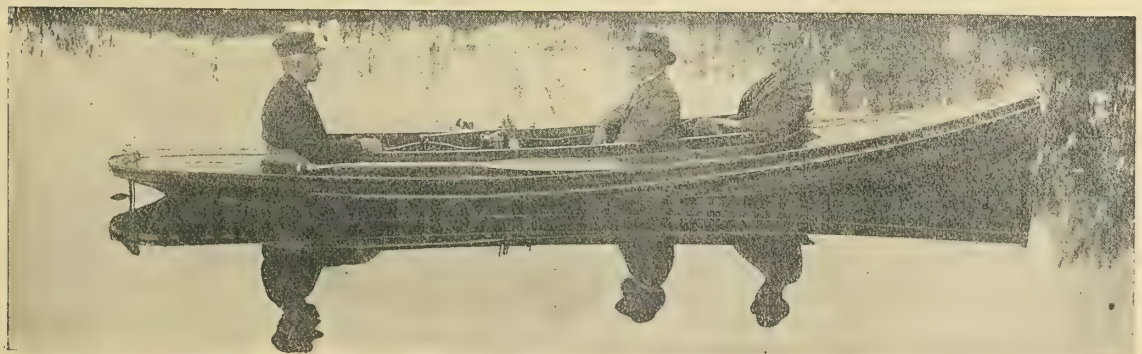
NOISELESS, FIRELESS, ODORLESS, ATTRACTIVE, INOFFENSIVE, INEXPENSIVE, NON-EXPLOSIVE, DURABLE, REVERSIBLE AND SAFE.

16-18-20 and 25-Foot **VAPOR LAUNCHES.** Price, $150, $165, $225, $375 and $475.

Carvel Build, Copper Fastened, Speed 6 to 9 Miles. Capacity 8 to 20 People. Larger Size to order. Price and Specifications upon Application. Also, all Sizes and Styles of Row and Sail Boats, Canoes, Dinghies, etc. Specialty of **HALF** and **ONE RATERS.** Send 8c. for Illustrated Catalog to

Box D. RACINE YACHT & BOAT WORKS, Racine Junction, Wis.

GAS ENGINES AND LAUNCHES.



WOLVERINE MOTOR WORKS, GRAND RAPIDS, MICH.

The Charles Hillman Ship and Engine Building Co.

Beach above Palmer St., Philadelphia.

The Chicago Ship Building Company,

SHIP BUILDERS AD ENGINEERS, = CHICAGO.

THE CLEVELAND SHIP BUILDING CO.

STEEL SHIPS, MARINE ENGINES AND BOILERS.

CRAMP'S SHIP YARD,

PHILADELPHIA, PA.

Battle Ships, Cruisers, Passenger and Freight Steamships, &c.

STEAM MACHINERY of every description, including boilers and all equipment; Marine Engines of any desired power, Gun Carriages, Basin Dry Dock and Marine Railway, Parsons' Manganese Bronze and White Brass, Water Tube Boilers (Niclausse, Mosher, Yarrow).

AREA OF PLANT, thirty-two acres. Area covered by buildings, fifteen acres. Delaware river front, 1,543 feet.

FLOATING DERRICK "ATLAS": capacity 130 tons, with 60 feet hoist and 36 feet out-hang of boom.

NUMBER OF MEN EMPLOYED, about 6,000 in all departments.

NEWPORT NEWS SHIPBUILDING & DRY DOCK CO.

WORKS AT NEWPORT NEWS, VA.

(ON HAMPTON ROADS.)

Equipped with a Simpson's Basin Dry Dock capable of docking a vessel 600 feet long, drawing 25 feet of water, at any stage of the tide. Repairs made promptly and at reasonable rates.

SHIP AND ENGINE BUILDERS. : : *For estimates and further particulars, address*

C. B. ORCUTT, Pres't, No. 1 Broadway, New York.

THE ATLANTIC WORKS, BORDER, MAVERICK AND NEW STS., (DOCKS OPP. NAVY YARD.) EAST BOSTON, MASS.

Builders of Steamships, Tow Boats and Steam Yachts, in Steel and Wood,

MARINE ENGINES, BOILERS, ETC. Hull, Boiler and Engine Repairs.

FRANKFORD STEEL COMPANY, ELLWOOD CITY, LAWRENCE CO., PA.

STEEL FORGINGS, HEAVY SHAFTINGS.

In the Rough, Rough Turned or Finished. Office, Fidelity Mutual Building, PHILADELPHIA.

A FORGING

of Fluid Compressed Open Hearth Steel, worked under an hydraulic press, has no equal.

——Particulars on application.——

THE BETHLEHEM IRON COMPANY,

SOUTH BETHLEHEM, PA.

NEW YORK - - - - - - 100 Broadway
CHICAGO - - - - - - Marquette Building
PHILADELPHIA - - - - - 421 Chestnut Street

MARINE ENGINEERING.

Vol. 2. NEW YORK, FEBRUARY, 1898. No. 2.

LAKE MICHIGAN CAR-FERRY STEAMER PERE MARQUETTE OF THE F. & P. M. R. R.

Our front page shows the magnificent lake car-ferry steamer Pere Marquette approaching Ludington, Mich., the western terminus of the Flint and Pere Marquette Railroad. In our issue of May last we published an extensive description of the design and construction of this vessel, which is the largest seagoing car-ferry in any waters. At that time, however, the photograph

LAKE MICHIGAN CAR-FERRY STEAMER PERE MARQUETTE APPROACHING LUDINGTON HARBOR.

which we are now able to present through the courtesy of the builders, F. W. Wheeler & Co., West Bay City, Mich., had not been taken. The general dimensions of the vessel are: Length, 350 ft.; breadth, 56 ft., and depth, from keel to upper deck, 36 ft. 3 in. When loaded with thirty freight cars she displaces 4,050 tons on 12 ft. 3 in. draught of water. In open water she easily reaches a speed of 16 miles, and she has a record of 10 miles an hour continuously through 14 in. of solid ice. The run between Ludington, Mich., and Manitowoc, Wis., is 56 miles and the trip is usually made in 3 1-2 hours. The Pere Marquette was built specially with a view to all-the-year-round service.

Vessels of this class have become very numerous on the lakes, especially on Lake Michigan, in the past few years. There are now fourteen large car-ferry steamers in operation with a total capacity of 287 cars, besides nineteen barge car floats towed by powerful tugs, which have track room for 145 cars, making a total for all boats of 432 cars. It will be remembered that when the Russian Government was contemplating the construction of ice crushing steamers for the trans-Siberian route, a board of experts was sent to this country to examine and report upon the lake vessels. As a result a ferry of the lake type was built for service on Lake Baikal.

QUADRUPLE-EXPANSION ENGINE AT FIVE HUNDRED POUNDS PRESSURE.*—II.

BY DR. R. H. THURSTON.

The investigation to be here described was made for the purpose of securing data which might afford some basis for inference of the probable gain to be actually secured by increase of steam-pressures to figures far above any at present in vogue, and to ascertain whether it may be fairly anticipated that, at such high pressures, we may secure as satisfactory approximation to the ideal case as with engines now in operation at standard steam-pressures.

The engine employed was designed, in consultation with the officers of Sibley College, by two graduates of the college engaged in advanced work, both of whom were good mechanics, as well as, as proved by their success in this instance, excellent designers and inventors—Messrs. Thos. Hall and Chas. H. Treat, members of the A. S. M. E., and now holding advanced degrees, from Cornell University, in engineering science. The research was mainly conducted by them, with such aid of officers and students as was available and applicable, and it was supplemented by independent work on the part of Messrs. Mitchel and Reeder and others. The design and construction and the experimental use of the engine occupied three years; the design and construction being entirely the work of Messrs. Hall and Treat. They introduced some new and valuable features, and their work admirably illustrates their mechanical skill. Continued use revealed opportunities to improve some minor points in construction of details; but, were the engine to be reproduced to-day, it may be doubted whether its builders would make any important changes in proportions or in the design of the engine or of its details.

The exterior of the engine, as finally constructed and operated, is seen in the engravings, Figs. 3 and 4; the former exhibiting the front, the latter the rear of the machine. Four cylinders were employed and the quadruple-expansion engine adopted as, with even the moderate ratio of three expansions in each cylinder, the total ratio, eighty-one, would suffice for, it was believed, practically any pressure to be employed in any experiments to be made. In fact, with a minimum terminal pressure of ten or fifteen pounds—which would not be likely to prove very far from figures of maximum economy with such an engine—the steam might be expanded from 1,000 pounds pressure with advantage. It would certainly give ample expansion for 500 pounds, absolute. The fact proved to be—whether due to leakage or other causes is not yet known—that the best work was done at 300 to 400 pounds. A system of reheaters in the boiler and flues permitted the re-evaporation between cylinders of any water of condensation; a reheater being set between each pair in series, or *en cascade*, as French engineers put it. Steam-jackets were not used. Provision was made for experimentally using non-conductors on heads and pistons, as proposed by many engineers, and as experimentally used on a small simple engine earlier. The cylinders are closely set and the cranks are at angles of 180 degrees, giving perfect balance. The engine has been driven at 500 revolutions per minute, loosely set on blocks, without shake or jar.

The valve-gearing exhibits the ingenuity of its designers, perhaps better than any other portion of the machine. As they stated:

"A suitable valve gear for an experimental engine is a difficult problem. It must give good steam distribution. It must be capable of adjustment for a wide range of cut-off, and compression, and release should also be under easy control. For this engine it must be capable of running at high speed.

"Plain slide valves are not adjustable. Separate steam and exhaust valves of this type would have added very greatly to the work of construction, and would not have fulfilled the requirement of ease in adjustment. Corliss gearing would not have withstood the high speed contemplated. A suitable gearing required to be positively connected and also required ample port area, and quick opening and closing of the valves, also ease in adjustment.[9]

"The gearing shown in the engraving was finally worked out. The steam valves admit steam through a slot in center. Steam is admitted by one edge of the slot and cut off by the other. Both events occur at each stroke of the valve, and the motion of the gearing need be only half as rapid as ordinarily, reducing the inertia effect to one-fourth. Spiral gears give this reduction of speed, and transmit the motion to the sliding-block movement on the front of the engine. This latter device operates to give the valves quick movement during admission, and reduces over-travel. It consists of a bell-crank carrying a block in the longer arm sliding in a slot in the wrist-plate. The other arm of the bell-crank lever is connected to the driving crank of the valve-motion driving shaft. Two of these motions are necessary, one controlling the steam valve at one end of any cylinder and the other the steam valve at the other end. The reason for two is, that one motion can give quick movement only once in a complete rotation; but one end of a cylinder must have steam 180 degrees after the other in a double-acting engine. By referring to the cut it will be seen that lost motion in the lower connections will be much reduced by the sliding-block device. When the block is near the end of the slot the wrist-plate will not move at all. When at the center of its travel the valves are wide open, and a little one way or the other makes no material difference.

* First chapter appeared in our issue of November, last.

[9] Power, 1895; *Trans.* A. S. M. E. 1896; No. DCCXVIII.

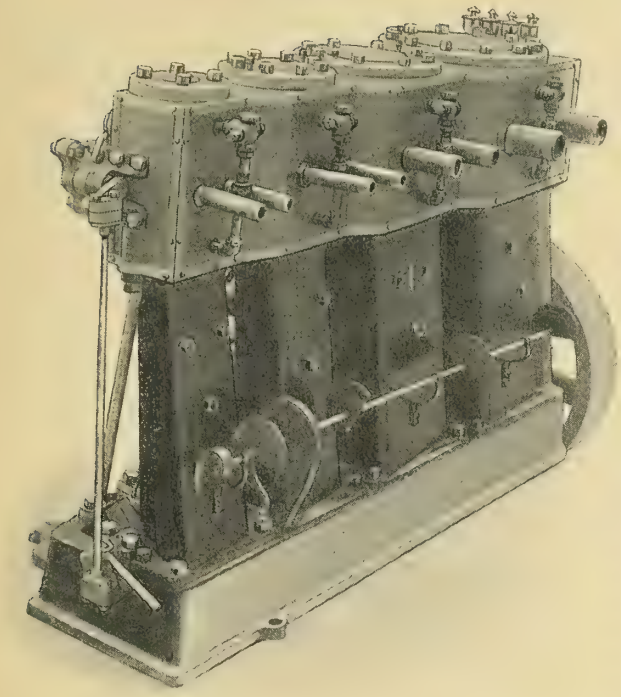


FIG. 4.—BACK VIEW OF EXPERIMENTAL ENGINE.

"When the block is moving at the end of the slot the fly-wheel may be turned thirteen out of thirty-two equal divisions of its circumference without producing any perceptible motion of the valve-arm, showing the extent to which over-travel of the valve is reduced. The valves are only one inch in diameter, yet some of the ports are more than three-eighths inch wide. As the valve passes over the port from one side to the other the port must always be completely opened during admission, no matter how early the cut-off. All steam-valve rods and rods transmitting motion to the sliding-block movement are made of bicycle tubing with ends brazed into them. The spiral gears are made of mild steel, to run in oil.

"The exhaust valves resemble the Corliss, and are driven by the crank at the end of the shaft. In case of accident, to stop the engine quickly, this crank may be loosened on the shaft, and so stop all the exhaust valves at once. This, in fact, is the usual method of stopping the engine, and proves both safe and handy. The steam valves lift, so that if an exhaust valve is left closed the steam in the cylinder is forced back into the previous receiver or into the boiler. If the valve is left open, on the other hand, steam may blow through into the next receiver. The receivers are provided with safety valves, so that the pressure in them can never become dangerous. By setting the engine at admission and changing this exhaust

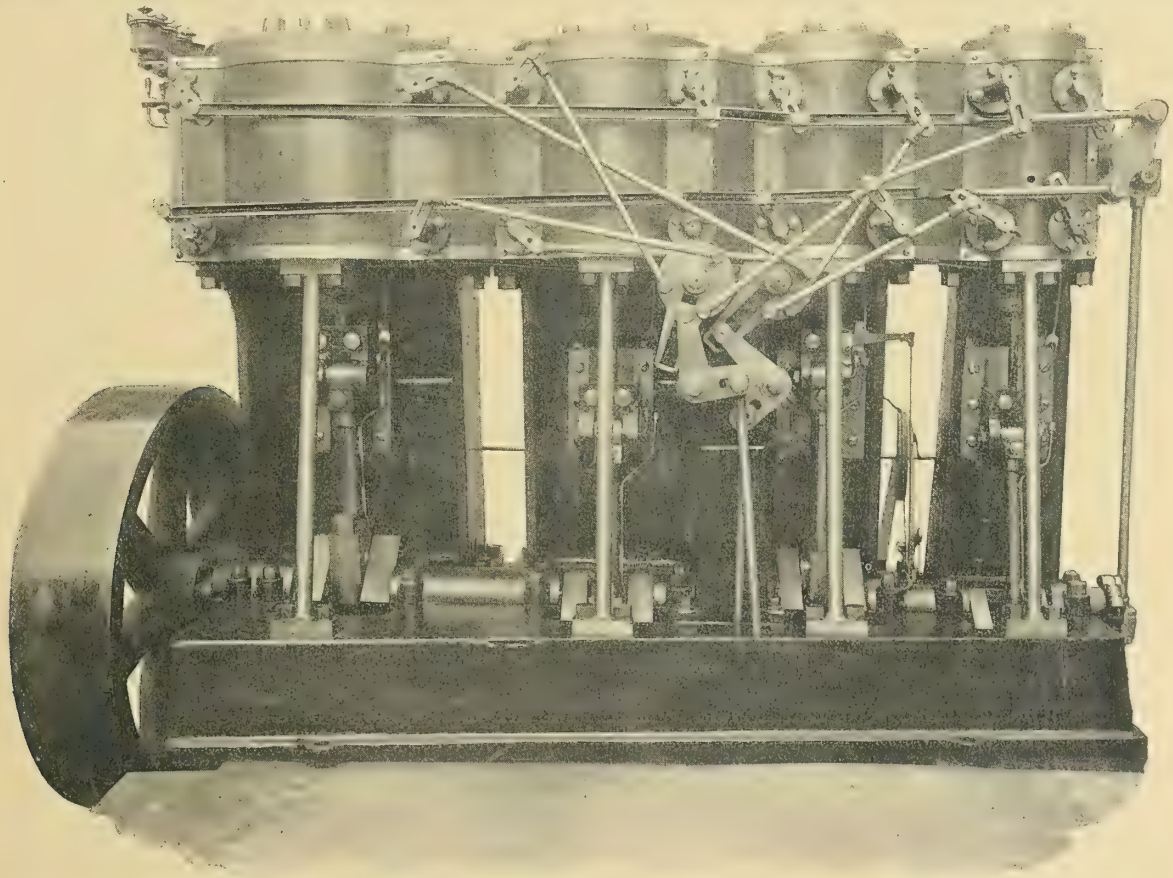


FIG. 3.—SIBLEY COLLEGE, FOUR-CYLINDER, QUADRUPLE-EXPANSION EXPERIMENTAL ENGINE.

crank, steam may be blown through the entire engine. This is convenient in warming it up.

"The stuffing-boxes are nearly long enough to prevent any of the rod exposed to steam reaching the outside air. They are packed with asbestos wicking and graphite. The deep stuffing-box is easy to keep tight.

"All parts are strong enough to carry full steam pressure in either of the first three cylinders and 150 pounds in the low pressure. This admits of any combination desired.

"As the number of cylinders and the rotative speed is increased, the work lost in friction becomes a greater and greater item. It is a large percentage of the total friction. To reduce it, the journals should be made as small as possible consistent with strength. This demands that the shaft be made of the strongest material obtainable. The extra first cost is very small compared to the saving it will make in a few years. The shaft in this engine was forged by the Bethlehem Iron Company, out of their steel. It was the only piece made outside the Sibley College shops."

The connections were so arranged that it was possible either to use the reheaters or to send the steam direct from cylinder to cylinder. The work was adjusted and measured by a friction-brake to which was ingeniously attached a fly-ball governor in such manner as to regulate the speed of the engine by tightening or slacking up the brake-band. An adjustable spring gave the required set load. An automatic recording apparatus was also mounted beside the brake, giving a continuous record of work performed and power exerted. (Fig.5.)

The boiler is an original construction, of water-tube type, designed for 1,000 pounds pressure and actually tested, when completed, at 1,350 pounds. It is shown in Fig. 6. It consists of an aggregation of coils of lap-welded, extra heavy, 1 1-4 in. steam pipe, about 100 ft. total length, set in five concentric coils. Steam- and mud- drums are attached, and a dry-pipe is introduced into the former. The drum is steel, lap-welded, 5-8 in. thick, and 12 in. dia. Its length is 6 1-2 ft. The heads are flat, held by a central stay-bolt reaching from the one to the other, and intended to act as a safety-valve, in case of necessity, stretching 1-2 in. under excessive pressure without risk, and to that extent allowing the heads to lift clear. Engine and boiler have been worked together without trouble at 620 pounds pressure.

In the work of investigation, special indicators were constructed to suit the extraordinary pressures employed, and every precaution taken to insure scientific accuracy of method and results.[10] The methods adopted were those which are accepted as standard in the practice of the Sibley College laboratories and by the profession. No special difficulty was met with in the conduct of the trials, apart from those coming of the peculiar conditions of the case especially such as, for example, were due to frequent breakage of water-gauge glasses and to trouble with injectors and pumps constructed for ordinary pressures. These were evaded, however, by the inventive talent of the experimentalists. Gauge-glasses were given

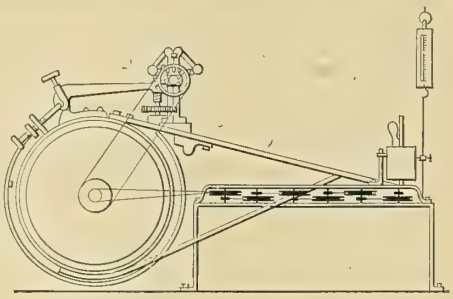


FIG. 5—AUTOMATIC BRAKE.

up and a float of aluminum, sustained by a fine wire rising through a fitted long drilled hole in the water-column, without packing of any kind, served, in the end, to give safe and satisfactory indications of the water-level. An old injector was rebuilt, with some success, to suit the thirty and more atmospheres pressure, and this was, in the end, superseded by a Worthington, high-pressure, duplex pump, which has proved entirely successful. The steam-gauge was tested to 1,000 pounds pressure, and standardized by a mercury column and the Emery testing machine of the college laboratory.

The engine was tested at a great variety of pressures, from 500 pounds at the boiler downward. The accompanying combined diagram, Fig. 7, shows the action of the steam when working at 300 pounds, which proved, on the whole,

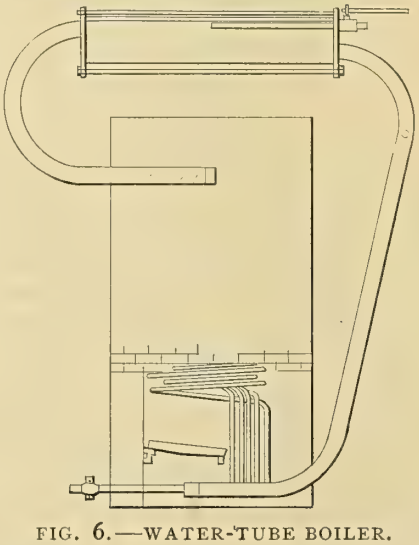


FIG. 6.—WATER-TUBE BOILER.

as economical a pressure as any. Its outer, smooth, curve is the pressure-volume curve for steam dry and saturated, and the intercepts between its abscissas and those of the expansion line of the diagram give the proportion of steam

[10] *Vide* Carpenter's "Experimental Engineering," or Thurston's Engine and Boiler Trials," and *Trans.* A. S. M. E., 1890 *et seq.*

existing, at every instant, in the engine as expansion progresses.[11]

The results of the trials made with this engine are best exhibited, for present purposes, in the diagram given in Marine Engineering, November, 1897, on page 23, "Fig. 1,"† in which *A* shows what would be the performance of the ideal engine, free from all extra-thermodynamic wastes with feed-water at 40 degrees Fahr. and steam-pressures rising from the minimum to 500 pounds per sq. in.; *B*, the actual performance of the engine with reheaters acting as effectively as was found practicable at the maximum pressure; *C*, the efficiencies when the steam was wet and no reheaters in use; *D*, the work of the engine with moderately effective reheating, and *E*, that of the machine with the most complete reduction of wastes attained in any of its trials, at that recorded with 300 pounds pressure. The curve *F* is drawn as that probably obtainable by the reproduction of this engine on a large scale, comparable with the work of the engines, of 500 to 1,000 horse-power, which have given the existing best records. This assumes the equivalent of extra-thermodynamic heat-wastes amounting to a net twenty per cent. approximately. The mechanical efficiency of the engine was between eighty-five and ninety-five per cent, varying with power developed and state of lubrication. With large engines this figure for friction-wastes has been reduced somewhat, but it is remarkably good for a small machine. The equation of these curves takes the form, as already stated,

$$W = m \diagup \log.\ p_1;$$

the constant, *m*, being about 18 for *A*, 25 for *B*, 30 for *C*. Large engines have already actually reduced this coefficient to 24, and it should be possible to equal this in large marine engines. With 1,100 *B. T. U.* supplied per pound of feed-water, a moderate proportion, the quantity of heat, measured in thermal units, which would be demanded, would rise about ten per cent. In the case of which the calorimetric analysis is here given, the amount supplied per pound of steam was actually 1,400, and the expenditure of heat about 13,500 *B. T. U.* per *I. H. P.* per hour. The dimensions of the principal elements of the engine, and its performance at moderate and most economical pressures, with varying conditions of re-heating, are condensed into the two following tables; made by filling out the regular blanks of the laboratory as used for this purpose. The quantity of heat per pound of steam varies, in all experiments, with variation in the quantity put into the fluid by the re-heaters and is a minimum for the curve marked *C*. in "Fig. 1,"† before

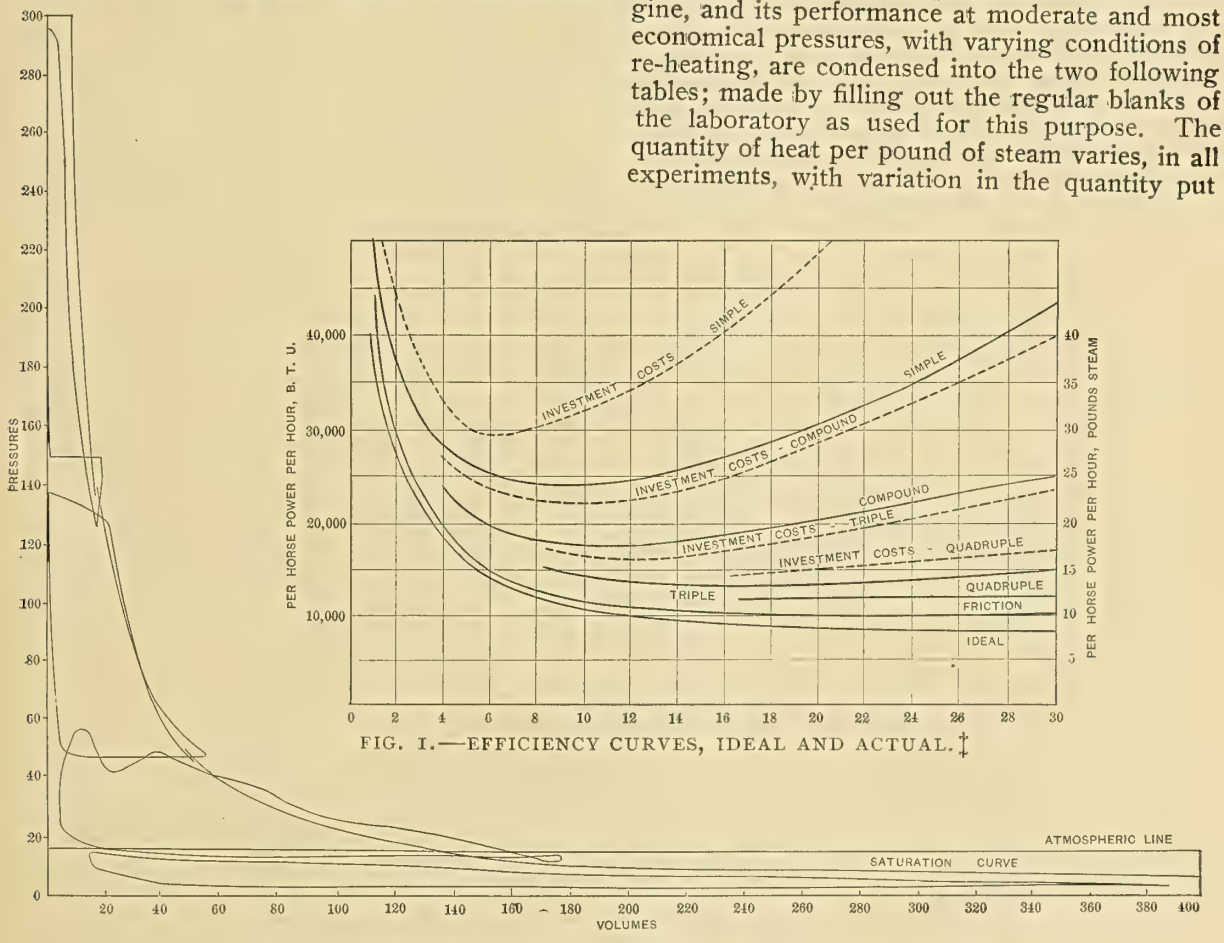


FIG. 1.—EFFICIENCY CURVES, IDEAL AND ACTUAL.‡

FIG. 7.—COMBINED DIAGRAM, QUADRUPLE-EXPANSION ENGINE.

[11] *Trans.* A. S. M. E., 1893, Vol. XV, p. 313; "The High Pressure Multiple-Expansion Engine;" R. H. Thurston.

†‡ NOTE.—"Fig. 1—Engine Efficiencies," on page 23 of November 1897, issue, should read "Fig. 8—Engine Efficiencies." and in the context "Fig. 1" should read "Fig. 8."

mentioned, and a maximum for curve *E*. The heat thus stored is largely waste heat for the boiler which would otherwise go arrangement and that of heaters and re-heaters and economizers, as well as upon the efficiency of the engine. The deficiency exhibited at the higher,

I.

SIBLEY COLLEGE, DEPARTMENT OF EXPERIMENTAL ENGINEERING.

DATA AND RESULTS. QUADRUPLE-EXPANSION ENGINE.

Built by Messrs. Hall & Treat, Sibley College, Cornell University.

			H. P.	1st I. P.	2d I. P.	L. P.
Kind of engine, quadruple expansion		Diameter of cylinder	inches	2,344	3,969	6,977	10,266
Duration of run	hours 6¼	Length of stroke	inches	4.5	4.5	4.5	4.5
Revolutions per minute	286.2	Diameter of piston-rod	inches	.5	.625	.875	1,125
Temperature condensing water, cold	degs. F. 34.87	Piston displacement crank end cubic inches		18,565	55,403	171,794	371,606
" " warm "	41.27	" " head " " "		19,449	55,710	172,395	372.6
" condensed steam	58.24	Volume of clearance, " " per cent		2.14	1.99	2.79	3.94
" engine room	73.80	" " " crank " " "		1.88	1.99	2.79	3.94
" external air	31.30	Make of indicator		Thompson.			
Boiler pressure gauge	lbs. 279.2	Spring	lbs. per inch	307	186.8	20 / 30	10
Barometer, 29.154 inches	lbs. 14.306	Length of brake-arm	feet	4.8021			
Condenser, 25.43 inches high	lbs. 12.479	Brake-load	lbs.	55.33			
Boiling temp., atmospheric pressure	degs. F. 210.75	Quality of steam at cut-off		See combined diagram.			
Total steam per hour, *C*, for engine	lbs. 106.53	" " " " release		"	"	"	
Total condensing water per hour	lbs. 16,632	Cut-off crank end, per cent, stroke		20.68	30.57	27.56	22.09
Wt. condensing water per pound, steam	156.15	" head " " "		26.38	36.82	31.89	31.27
Total I. H. P.	**11,095**	Release crank " " "		95.84	98.96	95.80	99.92
" D. H. P.	9,606	" head " " "		95.91	98.26	99.40	96.56
Mechanical efficiency	**86.88**	Compression crank, " "		3.4	10.	13.5	8.3
Moisture in steam	per cent. 2.49	" head " "		6.77	6.27	12.8	10.
Steam per I. H. P. per hour, actual	lbs. 9.51	Absolute pressure at point of cut-off	lbs.	264.10	110.325	39.40	10.67
" " I. H. P. per hour, corrected, cal.	lbs. **9.27**	" " " release	lbs.	115.154	44.43	14.30	4.08
" " D. H. P. " " " "	lbs. 10.81	" back pressure	lbs.	125.169	44.33	13.38	2.47
Water-rate of perfect engine	**6.86**	I. H. P. head		.868	1.727	1.738	1.44
Thermodynamic efficiency	**31.44**	I. H. P. crank		.804	1.534	1.771	1.621
Ratio actual to theoretical water consumption	1.38	Total I. H. P.		1.672	3.261	3.509	2.555
Heat supplied per hour B. T. U., by boiler	125,547	Steam per I. H. P. at point cut-off, per diagrams		4.86	8.60	7.71	4.071
" discharged per hour B. T. U.	109,240	" " " " " release, " "		8.99	10.94	11.72	8.912
" utilized per hour B. T. U.	28,236	Distribution of work. Total H. P. units		15.07	29.39	31.63	233
B. T. U. per I. H. P. per minute	**225.7**						
Ratio of expansion from combined card	**82.9**						

II.

SIBLEY COLLEGE, DEPARTMENT OF EXPERIMENTAL ENGINEERING.

DATA AND RESULTS. QUADRUPLE-EXPANSION ENGINE.

Trial made by N. S. Reeder, J. H. Mitchell.

			H. P.	1st I. P.	2d I. P.	L. P.
Kind of engine, quadruple expansion		Diameter of cylinder	inches	2,344	3,969	6,977	10,266
Duration of run	hours 3	Length of stroke	inches	4.5	4.5	4.5	4.5
Revolutions per minute	290	Diameter of piston-rod	inches	.5	.625	.875	1,125
Temperature condensing water, cold	degs. F. 68.95	Piston displacement crank end cubic inches		18,565	55,403	171,794	371,606
" " warm	degs. F. 83.33	" " head " " "		19,449	55,710	172,395	372.6
" condensed steam	95.38	Volume of clearance " " per cent		2.14	1.99	2.79	3.94
" engine room	96.2	" " " crank " " "		1.88	1.99	2.79	3.94
" external air	64.9	Make of indicator		Thompson.			
Boiler pressure gauge	lbs. 393.9	Spring	lbs. per inch	260.6	100	30	10
Barometer, 29.27 inches	lbs. 14.36	Length of brake-arm	feet	4.8021			
Condenser, 21.36 inches hg	lbs. 10.48	Brake, load	lbs.	55.046			
Boiling temp., atmospheric pressure	degs. F. 210.96	Quality of steam at cut-off		51.5	71.5	84	54.5
Total steam per hour, *C*, for engine	lbs. 129.3	" " " " release		90.5	100	Super.	100
Total condensing water per hour	lbs. 9,195	Steam, chest pressure gauge		....	....	....	....
Wt. condensing water per pound steam	71.1	Cut-off crank end, per cent, stroke		22.21	29.67	30.34	27.16
Total I. H. P.	10,634	" head " " "		26.45	34.02	33.72	31.83
" D. H. P.	9,217	Release crank " " "		100	97.27	98.51	100
Mechanical efficiency	87.22	" head " " "		100	97.52	100	97.29
Moisture in steam	per cent .94	Compression crank, " "		1.08	10.7	10.0	5.92
Steam per I. H. P. per hour, actual	lbs. 12.15	" head, " "		0	4.64	7.58	8.50
" " I. H. P. " " corrected, cal.	lbs. 12.03	Absolute pressure at point of cut-off	lbs.	265.34	101.56	37.35	13.27
" " D. H. P. " " " "	lbs. 13.89	" " " release	lbs.	120.37	55.45	18.98	6.72
Water-rate of perfect engine	7.54	" back pressure	lbs.	120.37	47.06	17.04	5.03
Thermodynamic efficiency	29.4	I. H. P. head		1,366	1,625	1.240	1,444
Ratio actual to theoretical water consumption	1.61	I. H. P. crank		.786	1,452	1,481	1,240
Heat supplied per hour B. T. U., by boiler	154,885	Total I. H. P.		2,152	3,077	2,721	2,684
" discharged per hour B. T. U.	140,446	Steam per I. H. P. at point cut-off, per diagram		5.10	7.50	7.65	6.12
" utilized per hour B. T. U.	27,063	" " " " " release "		9.85	11.35	12.69	10.07
B. T. U. per I. H. P. per minute	242.7	Distribution of work. H. P. as I.		20.23	28.93	25.58	25.23
Ratio of expansion from combined card	80.1						

to the chimney, and the true efficiency of the combination finally depends upon the extent of heating surface in the boiler, and its as compared with the lower pressure employed in these trials may have been due to leakage at those higher tensions; but this is not certain.

CONSTRUCTION AND OPERATION OF THE SUBMARINE BOAT ARGONAUT.

The very extraordinary submarine boat Argonaut now in the water at Baltimore, has been subjected to several practical tests lately, with an apparent large degree of success. This vessel, which we have referred to in past issues, is well shown in the accompanying photographs and scale drawing. The inventor, Simon Lake, had long in mind the construction of a boat which could not only travel under water, after the manner of other submarine boats, but could also make progress by mechanical contact with the bottom. The chief purpose in view was the recovery of treasure from sunken vessels on the coasts, using the boat as a fixed base of operations on the bottom, from which divers could work. A rough experimental boat was built by Mr. Lake about three years ago and the results then warranted the construction of the present well equipped steel boat.

The contract for the construction of the Argonaut was let to the Columbian Iron Works at Baltimore, and here the boat was put in the water last December. Her appearance upon completion is shown in the views taken shortly before the launch. The model of the boat is upon the familiar "cigar" lines, and its chief difference from the conventional form of submarine boat is the addition of wheels, two of large diameter forward (one on each side), and one of lesser size aft, occupying the place of a rudder.

Several tests of the diving, steering and locomotive powers of the boat have been made successfully during the past few weeks. During one of these, made on the Patapsco river, the boat was running on the bottom in water about up to the lights in the conning tower, when, coming to where the bottom sloped away sharply, in the channel, she dived easily, leaving only the inlet and exhaust air pipe floats in view on the surface, and after a while reappeared again on the opposite side in shallow water. During one test her speed was tried, with her conning tower showing above water, and the result was a mean of six miles an hour. The Submarine Boat Company is indeed so well satisfied with the results of these trials that preparations are now being made for wrecking operations. A tender will be built, which will be "cigar" shaped also, fitted with ballast tanks and four wheels. The tender will be used to load valuables recovered by the divers of the Argonaut, and will thus convey the treasure in bulk to the surface.

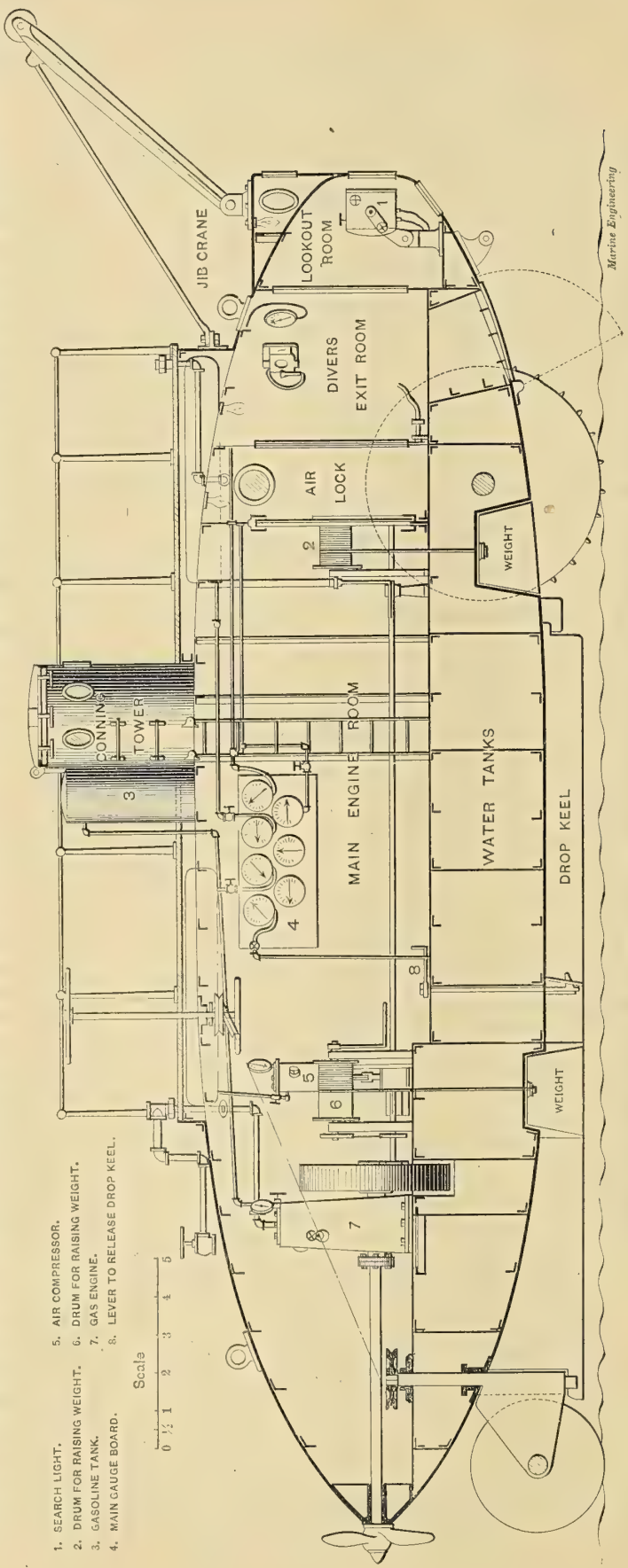
All the operations of the boat can, of course, be carried out only in a depth of water not too great for her strength. This is well within the point of collapse.

In general dimensions the Argonaut is 36 ft. long over all, 9 ft. maximum dia., tapering at each end to about 10 in. dia. She has a displacement of about 68 tons and a maximum of about 15 tons reserve buoyancy. The propelling power when floating is furnished by a White & Middleton gas engine of 50 H. P., driving a single screw 36 in. dia. and 30 in. pitch. This engine is also used by means of frictional gear to operate the dynamo, supplying current for sixteen 16 C. P. incandescent lamps, used in lighting the interior, and also current for a powerful search light located in the nose or lookout-room. The gas engine also supplies power for the air-compressor, raising and lowering of weights, and in turning the two forward traveling wheels for locomotion on the bottom. The interior arrangements are clearly shown in the drawing, but a description of the fittings will be of interest.

Starting from forward aft, the first compartment, the nose, is used as an under-water pilot house. Two lights are arranged on an angle, one on either side of the pilot, one directly ahead, and a fourth overhead. These are in addition to the search light, the rays of which can be projected in any direction forward or to the sides by the pilot. The question regarding the penetrative power of the search light rays has hardly been settled yet, but it is estimated that about 20 ft. to 25 ft. is the maximum. This, however, is considered sufficient for safety as, of course, obstacles are not very numerous when traveling submerged. In this compartment there is also an electric telephone, by which conversation can be carried on with the main engine room, and also with the diver who may be at work outside of the boat. Normal air pressure is supplied from the main compartment, as is also the current for the search and incandescent lights, all these connections being led through the bulkheads in stuffing boxes. The compartment next is the diver's operating room used in passing to and from the boat. This room, like the lookout room, is supplied with incandescent lights, electric telephone, and air pressures from the main engine room. It also contains the diver's appliances, rubber tubing and ropes and a connection to which the diver attaches his supply hose, and through which he receives normal pressure from the main operating room. When the diver is in readiness to go out the doors are sealed and the pressure in the room brought up to the outside water pressure; the door in the bottom of the boat is then unclamped and dropped down, and the pressures being equal the water does not enter the room. The diver uses the steps on the hull and door for convenience in passing to and fro. Besides the air tubing, he is supplied with a length of cable by which he can telephone to the main operating room. When re-entering the compartment the diver raises the door by a tackle, and having clamped the door securely the pressure is reduced to the normal; the diver then returns to the main operating room. The next compartment is simply an air lock lighted by an incandescent light and fitted with water-tight doors at both bulkheads.

Next aft is the main engine or operating room containing the machinery or vitals of the boat.

This room takes up the largest part of the boat, as will be seen on the profile inboard. Starting from the forward end of the space, there is fitted on the port side a cable drum used in raising and lowering the forward weight, another such drum being located in the after part of the room for the after weight. These weights are about 1,000 lbs. each and are used to pull the boat down to her desired depth. When on the surface the desired locality is attained, and everything being made ready for a trip to the bottom the two weights are lowered, by means of brakes on the drums, to the bottom; the distance the weights drop is registered by an ingenious device, and the depth is accordingly known for that spot. The buoyancy of the boat is then reduced until her reserve buoyancy is somewhat less than the combined weight of the weights. The cable drums then come into play again, as by winding up on them, either by hand or making connection with the gas engine, the boat will descend bodily provided both drums are wound equally as fast. The change in trim is noted by a pendulum near the gauge board. The boat descends until it comes to rest on the bottom with the weights in their original places. The next point of interest in the main room is the gauge board, also situated on the port side, about amidships. On this are located all the gauges, pressure, vacuum, air supply and exhaust, all regulated by valves in the vicinity. On the starboard side amidships just opposite the gauge board there is an electric switchboard and also an appliance telling the quantity of water let into the ballast tanks. The switchboard controls the search light in the lookout room, all the incandescent lights, and on it is also situated the telephone of the main room, connecting with the lookout, the diver and with the surface if necessary. On the same side just a little aft is the dynamo, which is operated by means of friction gear from the gas engine. The air compressor is on the port side opposite the dynamo. It is a special design of the inventor and is capable of storing air to 1,000 lbs. per sq. in. in the four tanks located in the superstructure, two forward and two aft as shown in the sketch. This compressor is also operated by the gas engine. Just abreast the compressor, but about the center of the boat, is the after cable drum before referred to. On the flat just forward of the cable drum a lever connects by a rod to a pawl for releasing the drop-keel. The drop-keel is simply a portion of

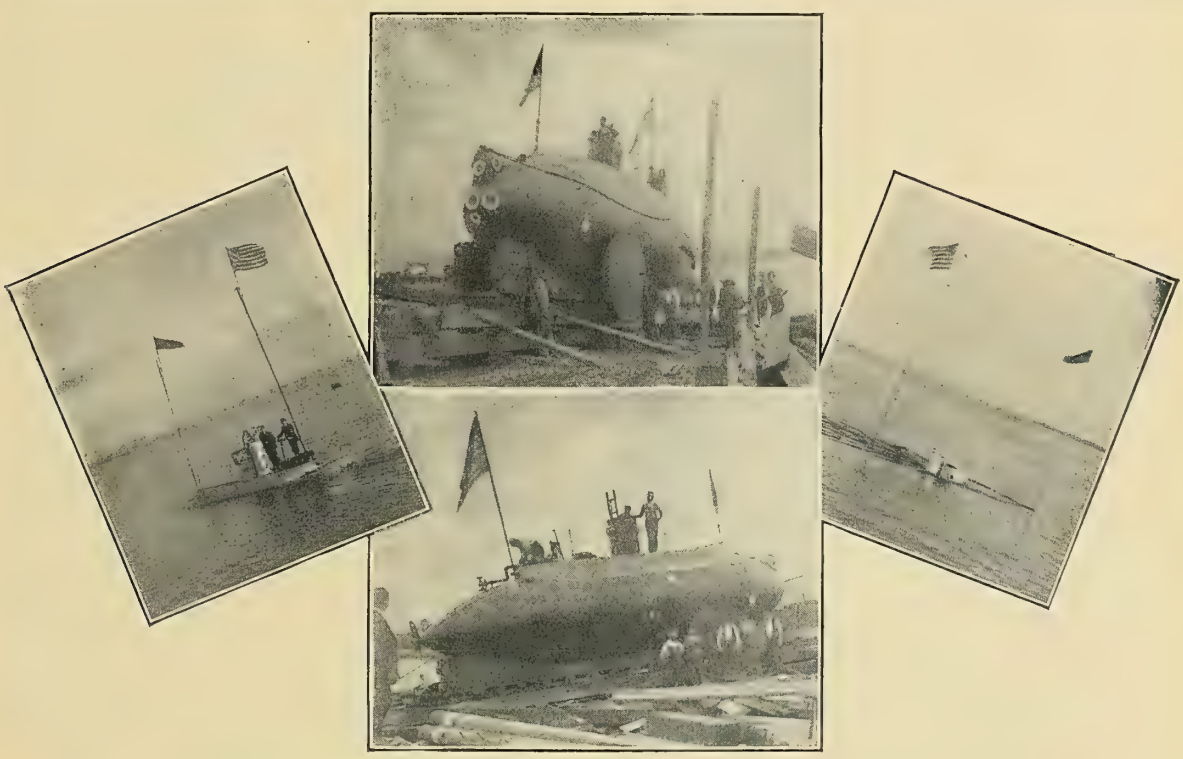


INBOARD PROFILE OF THE "LAKE" SUB-MARINE BOAT ARGONAUT, AT BALTIMORE.

the main keel and weighs about two tons. One end has a toe, which enters a recess in the fixed keel and in the other end is a slot to receive the pawl. The drop-keel is only for emergency use, in case something happened to the machinery or working part of the boat, and it became absolutely impossible otherwise to reach the surface when the boat was on the bottom. The lever referred to is turned and the pawl releasing one end of the drop-keel the other end drops out of the recess, and the boat, being two tons lighter, immediately ascends to the surface. After dropping the keel the location of it can be fixed by means of buoys or otherwise, to be recovered afterward. As it is a simple iron casting, however, its loss would not be serious.

Next, and perhaps the most important fixture of the boat is its motive power, in this case a gas engine, located in the center of the boat aft of the air compressor. It is of 50 H. P. and is supplied by a gasoline tank placed above the superstructure alongside and aft of the conning tower. The exhaust and air supply are fitted at each end of the superstructure, the former at the after end and the latter forward. The connections consist of hose nozzles made with great regard for water tightness at high pressure. Wire wound hose is used for both exhaust and supply, capable of withstanding the pressure at the maximum depth. The free end is kept on the surface by a special float designed to prevent waves or rough water from creating an inflow. Thus a fresh air supply is always guaranteed, and the exhaust is free to pass out unobstructed, and a constant circulation of fresh air through the boat is created. When on the surface these lengths of hose are coiled on the deck of the superstructure.

Abaft the gas engine comes the tail shafting and rudder head. The rudder, as will be seen in the sketch, is a combined affair, being used as a third wheel when running on the bottom, and also as a guide wheel. Chain leads are run out to the side of the hull over sheaves and thence up under the hull forward of the air compressor by means of other sheaves. A steering wheel is in place on the superstructure and another one under the shell near the compressor, one for surface work and one for under-water travel. The various pipes, valves, and gauges, in and around this compartment, are connections for air, water and gasoline supply, and are chiefly operated from the main gauge board. There is a ladder going up into the conning tower which is the main companionway of the boat. Beneath most of the compartments there are water-ballast tanks, with valves for flooding, and air pipe connections for discharging the water. In the conning tower there are five lights, and in the cover screw clamps for watertightness.



THE "ARGONAUT" BEFORE LAUNCHING AND WHEN RUNNING WITH HULL SUBMERGED.

The superstructure is a very light affair and is planked over to give deck room, having a rail around supported by stanchions.

Forward and aft on the hull are towing or mooring eyes and a crane is in position over the nose and stayed on the forward superstructure. The power is supplied from the gas engine operating a drum forward. This crane is for handling heavy wreckage.

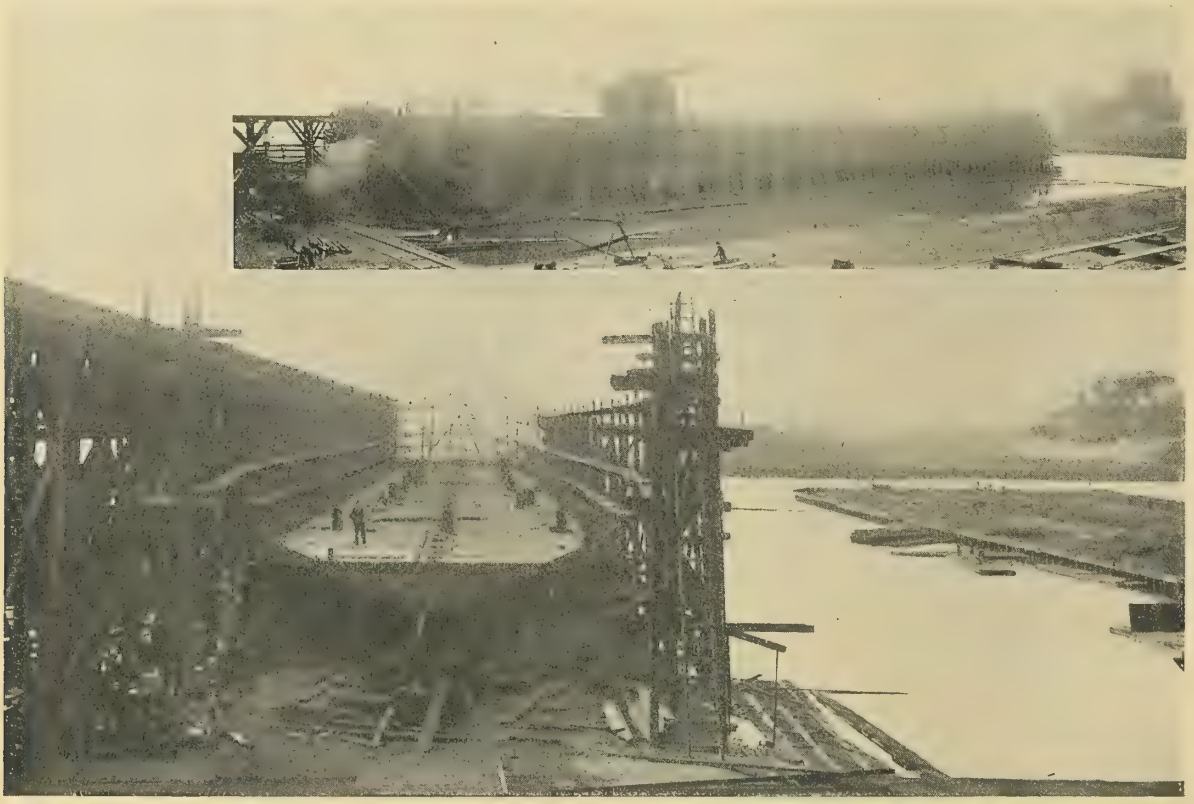
In the operation of the boat submerged, after the bottom has been touched by winding in the wire cable before described, the weights take their original positions and the boat is ready for "rolling along." The wheels forward are rotated by means of chain gear from the gas engine, and progress is made either with the propeller revolving or without. Five miles an hour was made on the bottom of the Patapsco river, which is very muddy, and it is expected that she will make much better time on a hard sand bottom. If the operator desires to return to the surface slowly he unwinds his cable drums and the boat ascends, leaving the weights on the bottom. On the surface her buoyancy is increased by discharging water and the weights are then drawn up again and she is ready to proceed. If the operator desires to come speedily to the surface he discharges water from his tanks, enough to overcome the weight of the two weights, and the boat rises instantly. In case of emergency, he uses the drop-keel to bring him to the surface.

Mr. Lake, the inventor and patentee, is a native of Pleasantville, N. J., where he was born in 1866. For many of the foregoing particulars we are indebted to the professional aid of George H. Wilson, of Baltimore.

It is probable that the first practical use to which the boat will be put is the recovery of about $30,000 in bullion, which went down in the "New Era," in 1854, off Asbury Park. The wreck lies in about 40 ft. of water.

Largest Tow Barge on the Great Lakes.

The accompanying photographs show the barge Australia on the stocks in the yard of builders, the Chicago Ship Building Company. She is a single decked tow barge for bulk freight only, and is the largest of her type on the lakes. Her dimensions are: Length over all 388 ft.; length on keel, 376 ft.; beam, molded, 48 ft., and depth 26 ft. It is estimated that she will carry 5,800 gross tons on 17 ft. draught. Her keel was laid on August 7 last and she was launched November 27. She has a 4 1-2 ft. double bottom for water ballast; twelve cargo hatches and three short masts without sails. She is provided with two stockless bower anchors and one stockless kedge, a steam capstan windlass, a steam capstan aft and a steam deck hoister amidships. Steam is supplied by an 8 ft. by 8 ft. single-furnace Scotch boiler, carrying 125 lbs. steam. Steering is effected from a pilot house amidships by a steam steering gear, and there is also hand gear fitted. Accommodations for the crew are in the half top-gallant forecastle and in wooden houses amidships and aft. The Australia is owned by James Corrigan, of Cleveland, and will be towed by some steamer of his fleet. One of the photographs was taken when the inner bottom was all in and the brackets in place to receive the lower ends of the side frames; the other when the hull was complete and ready for launching, except some riveting at the ends. She was put into the water several weeks ago.



TOW BARGE AUSTRALIA WHILE UNDER CONSTRUCTION AT CHICAGO SHIPBUILDING CO.'S YARD.

Condition of U. S. SS. Kearsarge and Kentucky.

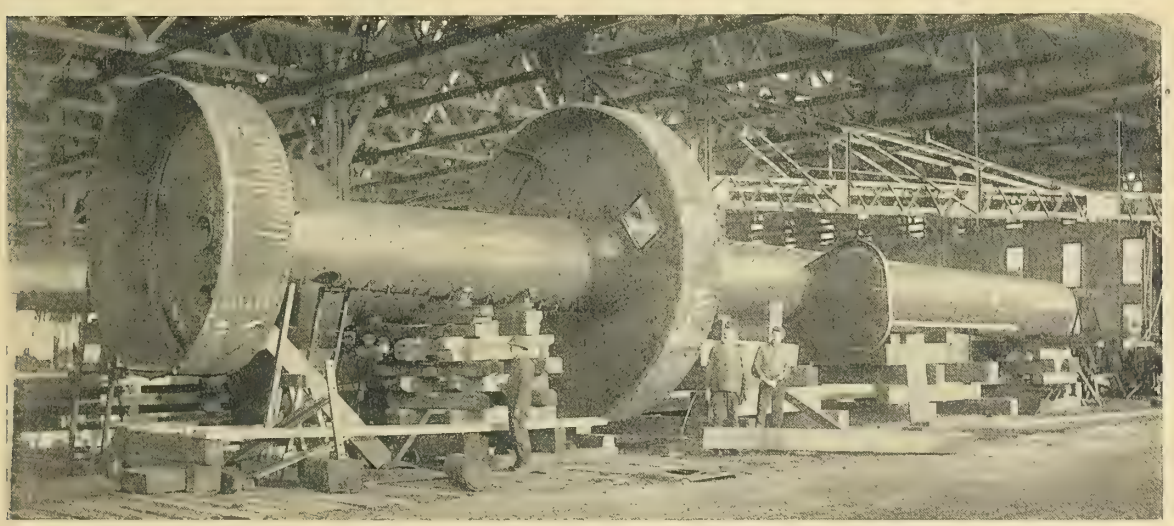
According to present plans the big battleships Kearsarge and Kentucky will be put into the water by the Newport News Shipbuilding Co. about the first of next month. Structural work is very far advanced on these two ships, though after the launch it will take a considerable time to install the machinery and fit them out for sea. Finishing touches are now being put on the launching ways at the yard. These are very massive and extend out into the water 106 ft., there being now 11 ft. of water over the farther end of the ways. The ways are fastened securely to the rows of piling underneath by chains and

ROW OF BOILERS FOR U. S. BATTLESHIPS IN SHIPYARD AT NEWPORT NEWS.

ring bolts coupled with turn buckles. Large gangs of skilled mechanics are hard at work in the ships, aided by every modern appliance. Pipe lines for compressed air are laid alongside the vessels and scores of pneumatic tools are in use inside. There are also the customary temporary machine shops on board, all the tools being driven by electric motors taking current from the power house up the yard. The tools include punches and shears, emery wheels, pipe-screwing machines and drill presses. There are also tool rooms in each vessel, so that much time is saved which would otherwise be lost by workmen going to and from the main shops.

The big ships will be launched with the end armor plates only in place, and they will probably go into the water without the propellers, but with the fighting tops in position.

In the erecting shops the engines for the twin screws of the ships are now up. They make a fine showing, being of very symmetrical design and finished with laborious care. The engines of one of the ships have been turned over by connecting the jacking engine with the shop steam main. The degree of care which is taken in the



RIVETING UP THE MILITARY MASTS FOR U. S. BATTLESHIPS AT NEWPORT NEWS.

construction of the machinery is plainly shown in the case of the manganese bronze propellers, the blades of which are ground approximately true with an emery wheel.

The company is going ahead with the preparations for finishing the ships. In the yard the big electric crane is assuming shape, and orders have been placed for flat cars, each capable of transporting a weight of 100 tons to any part of the yard, where tracks are laid.

General Superintendent Sommers N. Smith and his assistant, George Clarke, are already considering how they will take care of the tremendous crowd which will assemble at the launching.

DESCRIPTION OF THE NEW STEAM YACHT FOR COLONEL OLIVER H. PAYNE.

A contract for the construction of the largest steam yacht ever built in this country was made since our last issue, between Colonel Oliver H. Payne, of New York, and the Bath Iron Works, of Bath, Me. Colonel Payne last year chartered W. A. Slater's steam yacht Eleanor, which was constructed by the Bath Iron Works in 1893-94. Even at the present day she has the distinction of being the largest American built steam yacht afloat. She is a large seagoing craft of great cruising power and good speed and besides being fitted with an engine of 1,200 I. H. P., she spreads 13,500 sq. ft. of canvas. Colonel Payne was so pleased with the performance and general design of the Eleanor that when he decided to build a large vessel for himself he gave her builders, the Bath Iron Works, an opportunity to submit a design, and price, on a vessel which was to be superior to any pleasure craft at present afloat. English designers also were given an opportunity to submit plans, the owner's requirements being that the vessel should be capable of making long ocean cruises. This called for an unusually strong construction with heavy scantlings judiciously arranged to withstand the greatest wave strains and the pounding of the heaviest seas. The speed guaranteed was to be 15 knots an hour at sea in ordinary weather. No large reception rooms were desired, but plenty of deck room, for Colonel Payne is a sailor rather than a passenger aboard ship. Before the contract was let a number of competitive designs by home and foreign designers were examined.

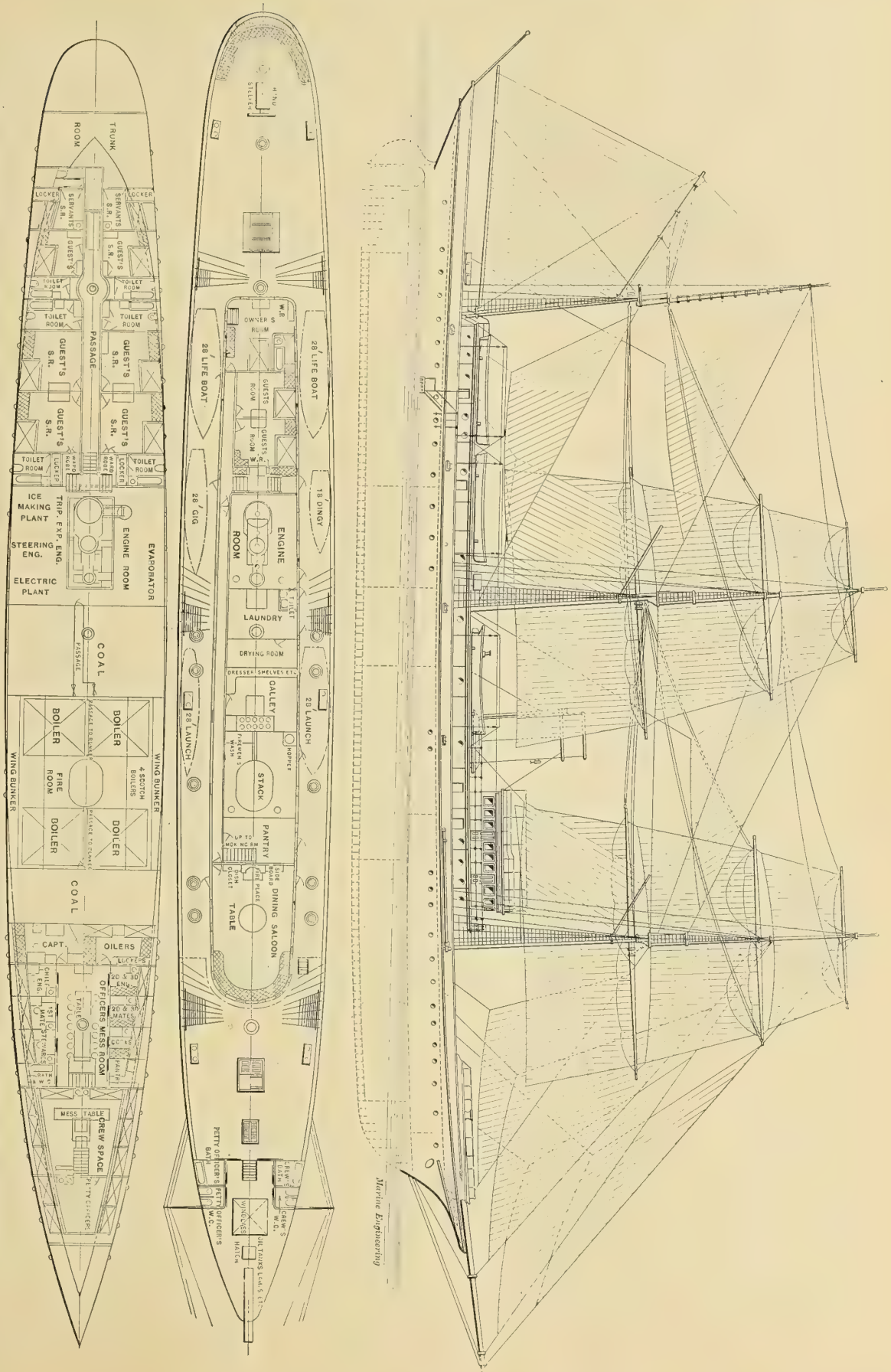
All the British designers, it is said, adopted twin screws in their plans. Charles R. Hanscom, designer and general superintendent of the Bath Iron Works, decided to use a single screw. He also designed a vessel with two-thirds sail power, so that the canvas could be used for steadying her in a seaway and in any emergency, such as a breakdown of the machinery, it would enable her to make fair speed. Unlike Mr. Watson's designs, in which the deckhouse extends the whole width of the ship, making an apartment as large as that of a country house, the Bath Iron Works' design shows a deck space of over 6 ft. in the clear between the rail and the house on either side. This somewhat narrows the rooms, but has the compensating advantage of a clear view forward, from the quarter deck, the length of the ship, instead of a vista of deckhouses, and also gives an unbroken promenade from stem to stern. The top of the deckhouse runs out to the rail, thus forming a shade deck, which answers the same purpose as awnings and at the same time makes a spacious unbroken promenade above. The Bath Iron Works' design conformed with Colonel Payne's idea of what a cruising yacht should be, and so the contract was signed.

Glancing at the general designs of the vessel, the well proportioned barque rig makes a favorable impression. About 17,000 sq. ft. of sail can be spread, so in a long cruise fires can be banked and good progress made by sail alone, by way of variety.

The general dimensions of the new vessel, which will be the largest, speediest and most luxuriously fitted ocean-going steam yacht ever constructed in this country, are as follows: Length, over all, about 301 ft.; length on load water line, 258 ft.; beam on load water line, 35 ft. 6 in.; molded depth at side, 21 ft. 4 in.; depth of hold, 20 ft.; mean draught, 15 ft.; draught aft, 15 ft. 9 in.; approximate gross tonnage, 1,300 tons. It will be noticed that the vessel has a round stern instead of the usual square stern now so common, especially with British steam yachts. This round stern was desired by Colonel Payne, and viewed from a position astern of the vessel, it will have a neat look. The yacht is a graceful, handsome, "shippy" boat. Though a powerful vessel, she has not that heavy appearance which seems to be characteristic of many modern full-powered steam yachts.

The machinery and coal spaces occupy 96 ft. of the vessel's length. Forward of the machinery space on the lower deck are the quarters for the officers and crew. At the extreme forward end a trimming tank extends to the lower deck, with a watertight compartment above this extending to the main deck. Abaft of this is a room 15 ft. long fitted so as to accommodate fifteen petty officers. The crew's quarters, sailors and firemen, is just abaft the petty officers' room. It is a commodious, airy and well lighted room, about 20 ft. long and the full width of the ship. It will be fitted with 24 berths, mess tables, dish closets, wash stands, drawers and other fittings. All berths for the crew will probably be made of pipe, with wire mattresses and sides. A companionway, common to both crew and petty officers, leads from the main deck at the aft end of the forecastle. The remainder of the space on the lower deck forward of the machinery is devoted to the ship's officers. A large mess room, 27 ft. long and 12 ft. wide, six average sized state rooms, two very large state rooms, with a bath room and pantry, are very well arranged in a fore and aft length of 36 ft. These rooms will be

PLANS OF THE SINGLE-SCREW STEAM YACHT FOR COLONEL OLIVER H. PAYNE, UNDER CONSTRUCTION AT THE BATH IRON WORKS.



finished in cherry and ash, with first-class furnishings. The two large state rooms are aft of the mess room; the one on the starboard side is the Captain's room, while the port room is fitted up to accommodate six oilers. The Captain's room will contain a full size bed, lounge, bureau, wardrobe, washstand, lockers, and a concealed bath and water closet. The remaining six state rooms are for the Chief Engineer, two assistant engineers, two mates, steward and cook. The entrance to the officers' mess room is located at the forward end by means of an adjustable stairway and square companion.

Abaft the after engine room bulkhead the space on the lower deck is devoted to the accommodation of the owner's guests. A passage about 4 ft. wide runs the entire length. The two forward state rooms on each side are unusually large, being about 14 ft. square. The two remaining guests' rooms are about 10 ft. square. There are also four large bath and toilet rooms, two 7 ft. long, and two 5 ft. long, each being the full width of the ship from the passage bulkhead to the side of the vessel. Two servants' rooms, 9 ft. long, each containing two berths, with a large bath room—common to both—are placed abaft the guests' rooms, the passage being bulkheaded across, communication being afforded by means of two swinging doors. The aft space on the lower deck will form a trunk and baggage room. The general arrangement, joiner work, silk tapestry, upholstery, furnishings and finish of these guests' rooms will be unexcelled, and will present a most magnificent appearance. At the present time, however, it would be out of place to attempt any description in detail of what as yet exists only on paper or in the minds of the owner and designer.

Colonel Payne's suite of rooms is on the main deck in the after part of the deckhouse. It consists of three state rooms and toilet room. The private room is a fine roomy apartment 16 ft. long by 15 ft. wide. Two other state rooms are about 10 ft. 6 in. long by 12 ft. wide. In the furnishing of these rooms expense will not be considered, and all this work will be done under the owner's direct supervision. The yacht will have no social hall, large saloon or reception hall, but an extra large dining saloon 30 ft. long and 18 ft. wide, fitted up most luxuriously, will occupy the forward part of the deckhouse. Abaft of this will be a stairway leading to the promenade deck above. Then comes a pantry, fire room hatch and a commodious galley. Amidships are located a large steam laundry, drying room and a deck water closet. Between the engine hatch casing and the owner's suite of rooms is the stairway leading below to the guests' rooms. Communication in bad weather between the dining saloon forward and the owner's and guests' accommodation aft is obtained by means of a passage in the starboard side of the deckhouse.

The deckhouse, which has large sliding round air ports, will be constructed of steel, sheathed with handsomely paneled mahogany. The total length of the deckhouse is 155 ft. A forecastle deck is fitted forward and this forms an excellent covering for a Hyde steam capstan windlass, besides affording a most desirable location for the petty officers and crew's bath rooms and water closets. Above the deckhouse on the forward promenade deck come the chart house, captain's office and bridge room, also a commodious, airy smoking room. Six boats will be carried on this deck, viz., two 28 ft. life boats, two 25 ft. launches, a 25 ft. owner's gig and an 18 ft. dingy.

The lower masts and yards will be of Oregon pine, the bowsprit will be of steel, and the remainder of the spars will be of spruce. A capstan is fitted on the forecastle deck, connected to the windlass, and on the quarter deck aft is located another steam capstan, with the engine below the main deck.

The machinery consists of a vertical inverted direct-acting, triple-expansion engine, the cylinders being about 28 in., 44 in., and 70 in., dia. with a common stroke of 38 in. The surface condenser will be of brass, cylindrical in form, the cooling surface being about 3,600 sq. ft. With about 130 revolutions this engine will indicate about 3,000 I. H. P. The propeller will be of manganese bronze, four bladed, of the built up type, the dia. being about 13 ft. Steam will be supplied by four large single-ended Scotch boilers, built for a working pressure of 165 lbs. per sq. in. These boilers will be about 14 ft. dia. and 12 ft. 6 in. long, and as each will have three 44 in. corrugated furnaces, the total number of furnaces will be twelve, so that about 250 H. P. per furnace will be developed with natural draft. The grate area of each boiler will be about 80 sq. ft., giving a total grate area of 320 sq. ft. for all four boilers. The total heating surface will be about 10,500 sq. ft. Owing to the boiler power being divided into four units, no donkey boiler will be fitted. In the engine room the most modern improved ice making machinery will be located, also an evaporator, electric plant in duplicate, and a steam steering engine. The vessel has two large athwartship coal bunkers, one forward and one aft of the boiler room, there being but one fire room, as shown in the general arrangement sketch. The forward bunker has a capacity of 140 tons of coal, and the amidship one will hold about 280 tons. There are also wing bunkers running the whole length of the boiler room, and these will bring the total coal bunker capacity up to 480 tons.

A passageway through the amidship bunker connects the fire room and engine room. In the after hold an electric storage battery will be fitted with a capacity sufficient to light the entire vessel for about 12 hours. Six large fresh water tanks are located just forward of the aft peak bulkhead, with a total capacity of over 30 tons of fresh water. The remain-

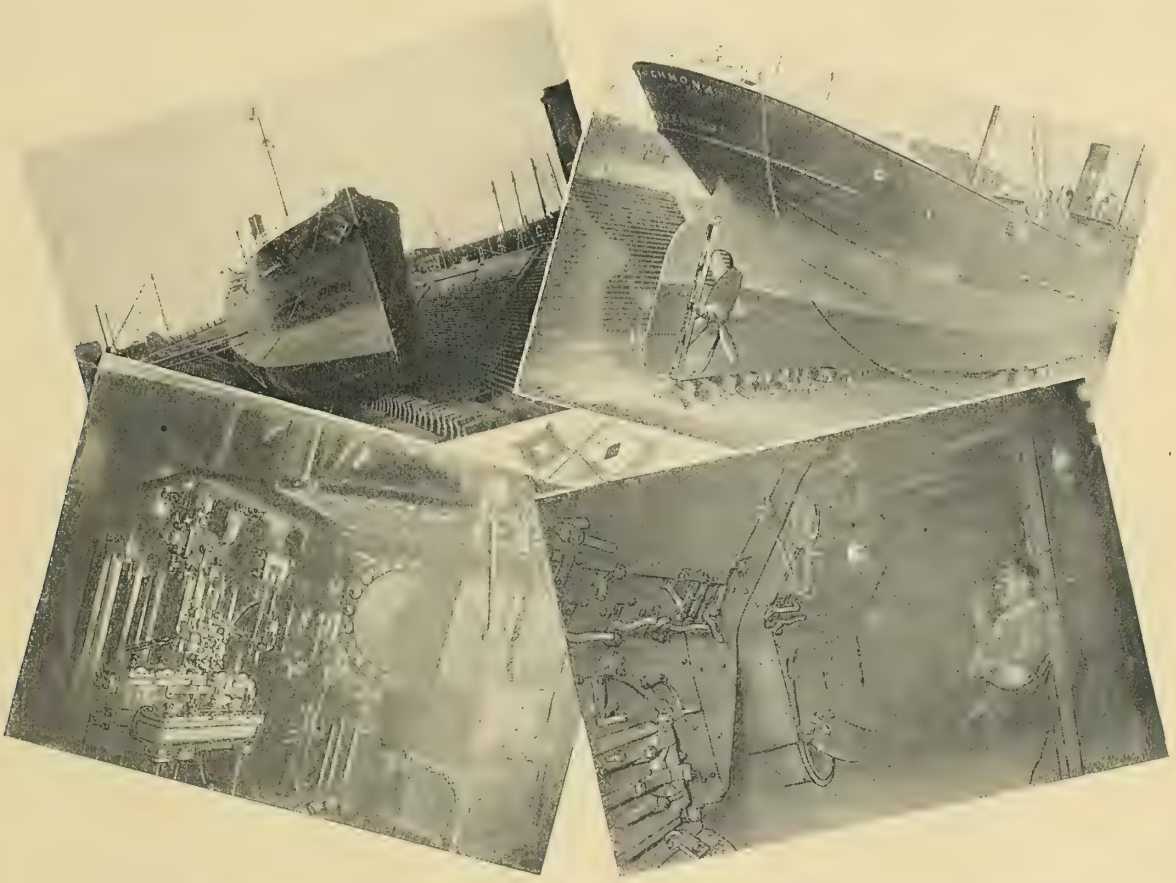
der of the after hold is subdivided into engineer's stores, cabin stores, ice making room, wine room and armory. In the forward hold are located the cold storage rooms, with separate rooms for meat, fish and fowl. The remainder of the space in this hold is occupied by chain lockers, general stores, provisions, boatswain's stores and sail rooms.

A double bottom forming water ballast tanks is worked in the forward and after holds, but not in the machinery spaces nor in the extreme ends of the vessel. The subdivision of the hull is first class, as the vessel is fitted with seven complete transverse bulkheads.

The speed of the yacht will be 15 knots, or nearly 17 1-2 statute miles per hour at sea, in ordinary weather under steam alone with natural draft. Assisted or forced draft will probably be fitted later. The latest British built steam yachts of this size are credited with a speed of about 16 knots at full power, but it must be remembered that this is a trial trip speed under forced draft, and such results are seldom, if ever, attained again even under the most favorable circumstances. These boats have a sea speed of about 14 knots to 14 1-2 knots per hour. The new yacht will, therefore, be a speedier vessel than the latest British designed steam yacht, for when assisted by her canvas, or by a slight air pressure in the stokehold, the speed will be increased to about 17 knots per hour. At a cruising speed of 12 knots per hour, Colonel Payne's yacht will have a radius of action of over 5,000 knots, and she will have abundant coal to enable her to cross the Atlantic at full speed.

Machinery Equipment of the S. S. Inchmona.

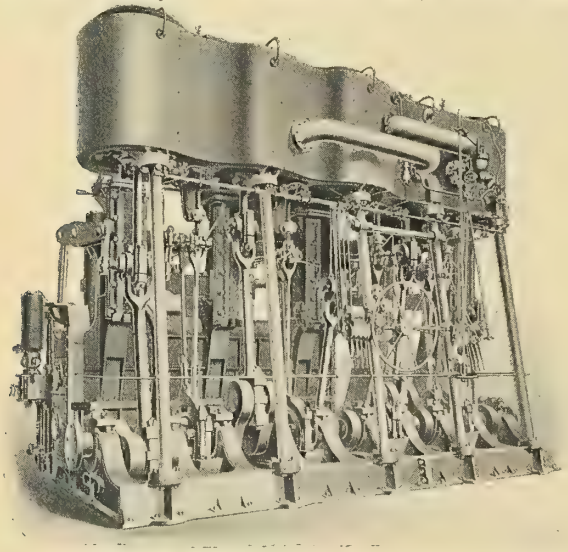
An interesting freight steamer, the Inchmona, loaded in New York harbor last month for the American and Indian S.S. Line, which has just been established for the direct shipment of cargo to East Indian ports. This steamer lays claim to the title of most economical freight carrier afloat. She was launched in 1896, at West Hartlepool, on the east coast of England, and attracted a very considerable amount of attention in the technical press everywhere on account of her equipment and trial record. We here publish several exterior and interior views from photographs taken while the vessel was at the yard of the Erie Basin Dry Dock Co., Brooklyn, where she was made ready for the long voyage.



VIEWS OF THE HULL AND MACHINERY EQUIPMENT OF THE FREIGHT STEAMER INCHMONA.

The Inchmona is 335 ft. long, over all; 46 ft. 7 in. beam, and 15 ft. 2 in. deep. Her tonnage is 3,215 gross, and 2,223 net. She is fitted with

water ballast tanks holding 1,061 tons and carries 330 tons of coal in her bunkers. As will be noticed in the views, she has very full lines, a perfectly flat bottom, and is fitted with bilge keels. Her machinery is of the most modern type, designed to give maximum efficiency at minimum expense of operation. The main engine is of the five-cylinder, five-crank, quadruple expansion type, with cylinders 17 in., 24 in., 34 in., and two 42 in. dia. and 42 in. stroke. The design is quite modern, including wrought iron front columns, built up interchangeable crank shaft, with eccentrics on couplings, single slide cross heads, and Stephenson double bar link motion. The valves are in the center line of the cylinder, the high pressure a piston valve, and the others slide valves. The condenser extends along the back frames, the length of three cranks, and carries the reversing engine on its top, so that the front of the main engine is clear of everything except the starting gear. The air pump and bilge pumps are worked by levers from the L. P. cross head



FIVE-CYLINDER, FIVE-CRANK, QUADRUPLE-EXPANSION ENGINE OF S. S. INCHMONA.

in the usual style. The separate units of the engine are carefully balanced, and this with the five cranks gives a very even rotative effort, there being ten impulses at regular intervals during each revolution. The exact figures on horse power are not obtainable, but from available data it figures out about 1,050 I. H. P. It is doubtful, however, if any advantage is gained by this type of engine, as it is of great size for the power developed, and the multiplicity of working parts bespeaks a considerable extra first cost and after expense for upkeep. There are two single ended Scotch boilers, each fitted with two small furnaces. The working pressure is about 250 pounds per sq. in. The construction of the boilers is peculiar, in that the ends are flat plates riveted to flanges on the shell. The Ellis and Eaves system of hot draft is used and the boilers are also fitted with Serves tubes. A superheater is fitted in the uptakes, and there is a special Weir's system of hot feed by which as high a temperature as 400 deg. F. has been reached. At sea with a full cargo the Inchmona averages 9 knots, on a consumption of about 13 tons of best Welsh coal. When she came out a record of .999lbs. of coal was generally conceded.

On her trip from here, which commenced January 6, she carried steel rails, petroleum, domestics and miscellaneous cargo. Norton & Son, of New York, the general agents of the line, expect to maintain a thirty days' service.

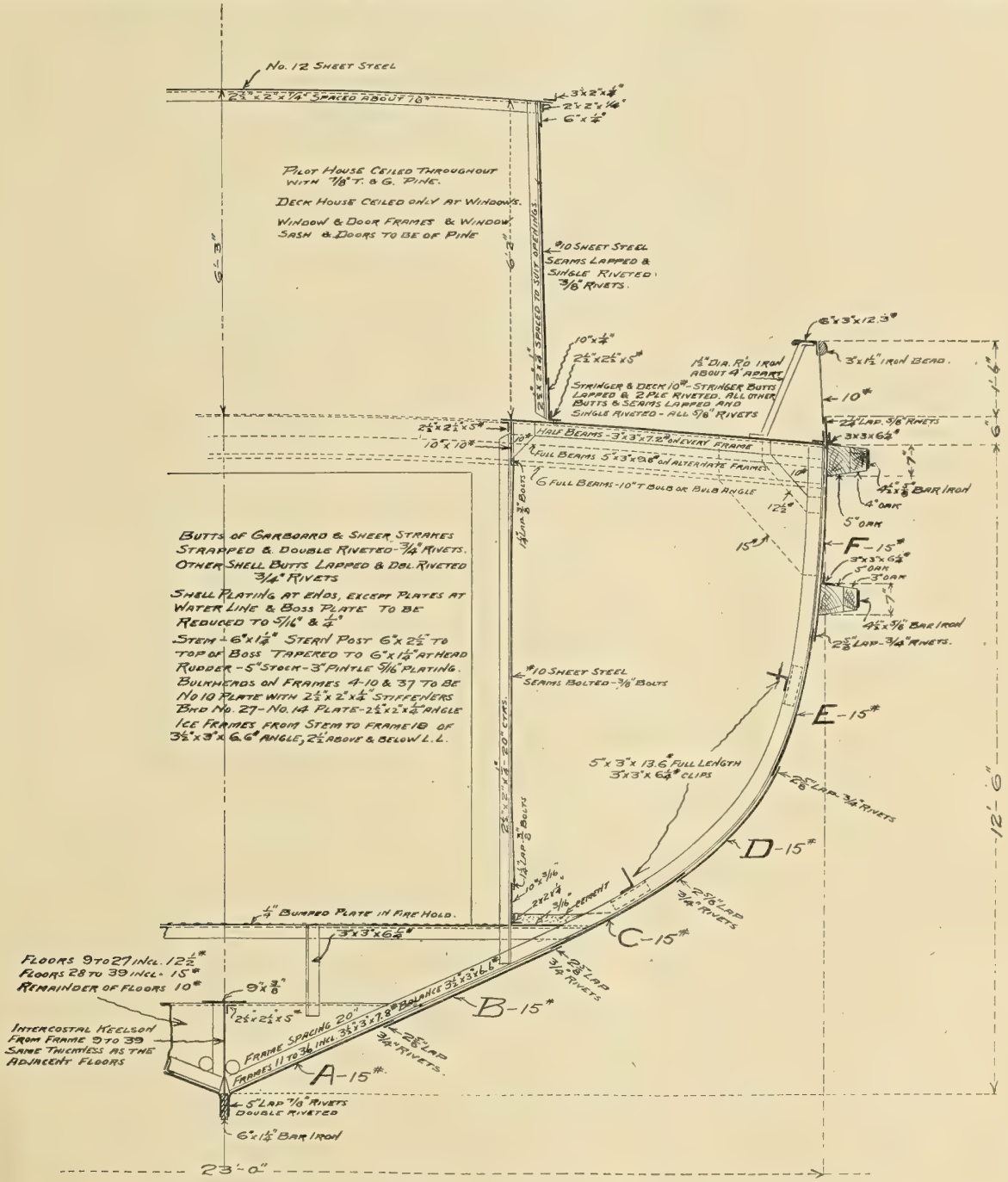
New Boilers for the S.S. La Grande Duchesse.

Work was commenced last month tearing out the water-tube boilers of the Plant Line steamer La Grande Duchesse, to make room for the installation of Scotch marine boilers, which has been decided upon. The vessel is now lying at the builders' yard in Newport News, where the new boilers will be constructed. Up to the time of the removal of her boilers, which were of the Babcock and Wilcox make, the La Grande Duchesse had the largest equipment of water-tube boilers of any American seagoing vessel. There were eight Babcock and Wilcox boilers set back to back on the keel line, with the fire rooms against the sides of the ship. These boilers were fitted with tubes 4 in. and 2 in. dia., and 7 ft. 3 in. long of charcoal iron expanded into hydraulic forged steel headers. They were adapted to forced draught and a working pressure of 225 lbs. per sq. in.

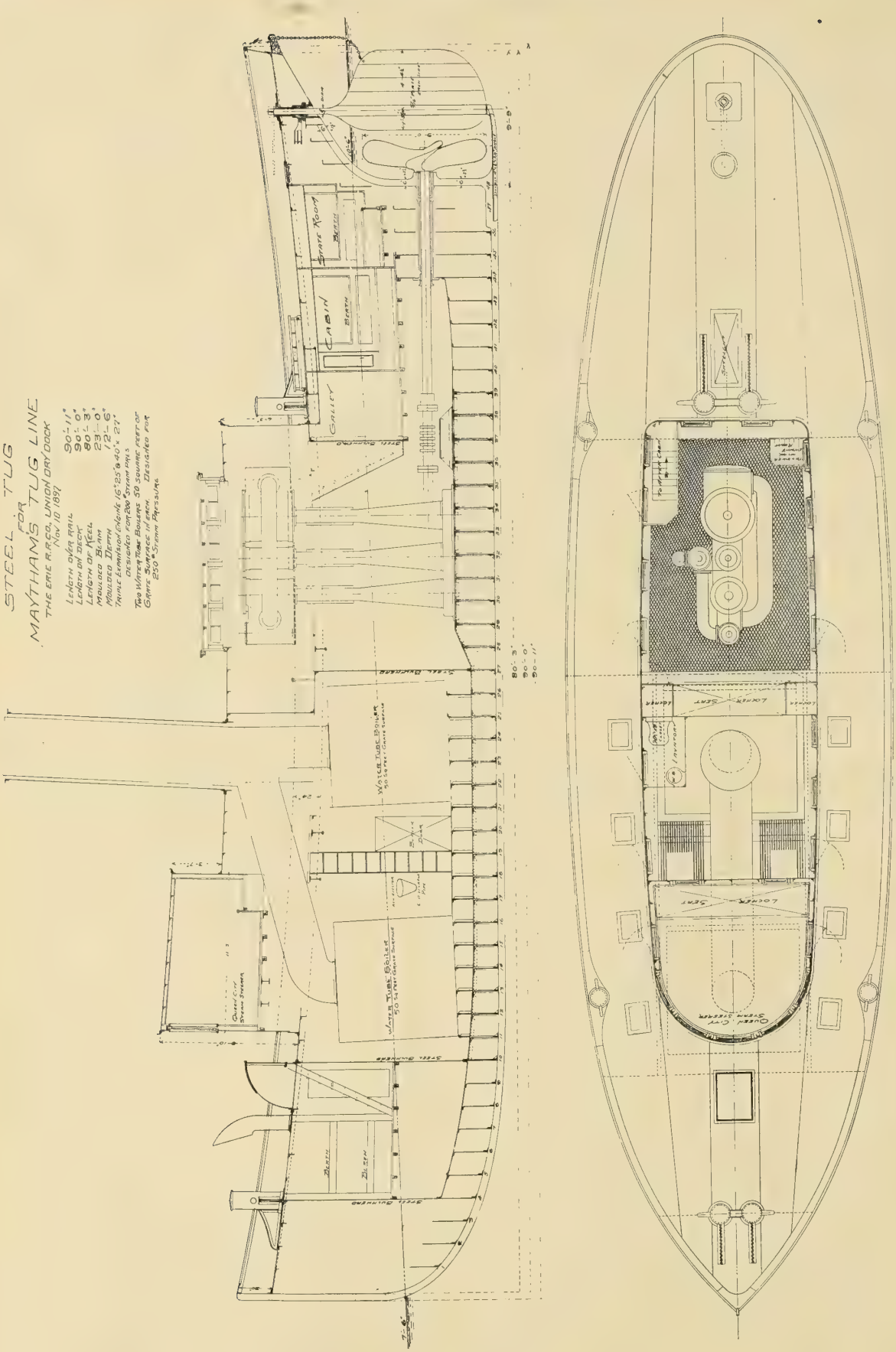
The new Scotch boilers will be the heaviest job ever undertaken in this country, and the plates are now being specially rolled. There will be two double-ended boilers 15 ft. 3 in. dia. and 20 ft. long, and two single-ended boilers 15 ft. 3 in. dia. and 11 ft. long, built for a working pressure of 210 lbs. The shell plates for these boilers will be of the tremendous thickness of 1 5-8 in. They will be fitted with Fox corrugated furnaces and plain tubes with retarders. A complete equipment of Ellis and Eaves induced draught will be fitted with the boilers. The double-ended boilers will each weigh over 100 tons, or as much as the heaviest locomotive ever built for freight traffic. The boilers will be placed across the keel line so that the fire rooms will be athwart ships, and the present smokestack will likely be retained. The La Grande Duchesse, which has been running on the Savannah line during the summer, is 404 ft. long over all, 47 ft. 9 in. beam and 37 ft. 4 in. deep. She displaces about 5,600 tons on a mean draught of 17 ft. 4 in. She has accommodation for 700 passengers and 3,000 tons of freight. The propelling machinery consists of two sets of quadruple-expansion engines, with cylinders 24 in., 34 in., 48 in., and 68 in. dia., and 42 in. stroke. The screws are 14 ft. 6 in. dia. and 18 ft. pitch, and the vessel has a sea speed of 17 knots.

Details of a Modern Type of Lake Tugboat.

A strictly modern American tugboat now building at the Union Dry Dock in Buffalo is shown in the drawings herewith. The machinery equipment, as will be noticed, includes water-tube boilers and triple-expansion engines. The tug is building for Maytham's tug line from designs by Edward Gaskin. She is a steel boat, in dimensions: 90 ft. long on deck, 23 ft. beam molded and 12 ft. 6 in. deep molded. She is fitted with four steel bulkheads. Her displacement is 204 tons and the center of buoyancy is 2.45 ft. aft of dead flat section. The machinery equipment includes two water-tube boilers to carry a pressure of 250 pounds, each having 50 sq. ft. grate surface. The engine is of the triple-expansion type, designed to work at 200 pounds pressure, with cylinders 16 in., 25 in. and 40 in. dia. by 27 in. stroke. The weight of engines, including condenser and pumps, is 37.20 tons; weight of each boiler and water 17.125 tons, or 34.25 tons for both; weight of hull and outfit, including steam steerer, anchor chain, and other fittings, and 25 tons of fuel, is 132.25 tons.


No. 12 Sheet Steel
Pilot House Ceiled Throughout with 7/8" T. & G. Pine.
Deck House Ceiled only at Windows.
Window & Door Frames & Window Sash & Doors to be of Pine
9/10 Sheet Steel Seams Lapped & Single Riveted 3/8" Rivets.
Stringer & Deck 10# - Stringer Butts Lapped & 2 Ple Riveted. All other Butts & Seams Lapped and Single Riveted - All 5/8" Rivets
1½" Dia. Rd Iron about 4' Apart
3"x1½" Iron Bead.
Half Beams - 3"x3"x7.2# on every Frame
Full Beams 5"x3"x9.8# on alternate Frames
6 Full Beams - 10" T Bulb or Bulb Angle
Butts of Garboard & Sheer Strakes Strapped & Double Riveted - 3/4" Rivets. Other Shell Butts Lapped & Dbl. Riveted 3/4" Rivets
Shell Plating at Ends, except Plates at Water Line & Boss Plate to be Reduced to 5/16" & 1/4"
Stem - 6"x1⅝" Stern Post 6"x2½" to top of Boss Tapered to 6"x1½" at Head
Rudder - 5" Stock - 3" Pintle 5/16" Plating.
Bulkheads on Frames 4-10 & 37 to be No 10 Plate with 2½"x2"x¼" Stiffeners
Bhd No. 27 - No. 14 Plate - 2½"x2"x¼" Angle
Ice Frames from Stem to Frame 18 of 3½"x3"x6.6# Angle, 2½" above & below L.L.
#10 Sheet Steel Seams Bolted - 3/8" Bolts
5"x3"x13.6# Full Length 3"x3"x6.4# Clips
4" Bumped Plate in Fire Hold.
Floors 9 to 27 Incl. 12½#
Floors 28 to 39 Incl. 15#
Remainder of Floors 10#
Intercostal Keelson from Frame 9 to 39 Same Thickness as the Adjacent Floors
Frame Spacing 20"
Frames 11 to 36 Incl. 3½"x3"x7.8# Balance 3½"x3"x6.4#
5" Lap 7/8" Rivets Double Riveted
6"x1¼" Bar Iron
A-15#
B-15#
C-15#
D-15#
E-15#
F-15#
23'-0"
12'-6"

HALF CROSS-SECTION OF STEEL TUG BOAT FOR SERVICE ON THE GREAT LAKES.



DRAWINGS OF STEEL LAKE TUG NOW UNDER CONSTRUCTION AT THE UNION DRY DOCK, BUFFALO, N. Y.

The tug is intended chiefly to tow a dump scow 175 ft. long by 25 ft. beam by 12 ft. deep, and 10 1-2 ft. draught, used for carrying 650 tons of gravel. The length of tow is about 3 miles, and portion of the course is against a 7 mile an hour current. The tug will, however, be used also for harbor towing and is designed so that she can carry 60 tons of coal in the bunkers and 10 tons on deck, when long distance towing is to be done. The dimensions of the tug were, of course, limited by the port conditions, so that it was not possible to give her greater length, and at same time the size and weight of machinery made a large beam necessary. Owing to the limitations on the length, trimming tanks could not be used forward and aft, and the limit of draught, 10 1-2 feet, made it necessary to take special care in all calculations to obtain the proper immersion and trim. Sectional drawings are here presented. In the longitudinal section, the forward position of the towing bitts, just abaft the engine trunk, will be noted, this being done to prevent a tow "getting the best" of the tug in a heavy current or in close places.

ESTIMATED WEIGHTS OF MACHINERY, WITH FORMULAE FOR SCREW AND SIDE-WHEEL STEAMERS.*—I.

BY PROF. GEO. R. M'DERMOTT.

The leading conditions to be fulfilled in the design of any steamer may be generally stated as the carrying of a given dead weight, a certain distance, within a stated time, while performing such other functions as may be peculiar to the service for which the vessel is intended (warship or mercantile) within the limitations of dimensions which are possible or which have been found, by experience, to give the best results.

In the initial stages the various steps in the solution of the problem are of a tentative nature, consisting of a series of approximations to the value of certain quantities, such as horse power, weight of hull, weight of machinery, weight of coal, etc., and the success of the designer in producing an efficient vessel is, in a large measure, dependent on the accuracy with which the above quantities are evaluated.

Confining himself within the limits set by the title of this paper, the writer wishes to present the result of some investigations which he has made regarding methods of determining the weights of machinery of steamships. Each designer has his own methods, but in the preliminary work, given the required horse power, and type of engine and boilers selected as most suitable for a given case, it is usual to make a shot at the weight of machinery on a basis of pounds—or tons—per I. H. P., or it may be that the weights of engines and boilers are estimated separately, the engines on a basis of I. H. P., and the boilers on that of heating surface, grate surface, etc., the necessary information to permit of this being done having been selected from the storehouse of his experience. In the first stages of the design this method is probably as good as any; in fact, in the generality of cases, the dimensions of the engines, boilers, etc., are not definitely fixed until a later stage, and the designer is forced to adopt some such method.

Unless great care is taken in selecting a suitable weight per I. H. P., or heating surface, implicit reliance should not be placed on the weights derived in such a manner. Undoubtedly, where the types from which the data has been selected are not very different from that of the proposed machinery, a fair approach to accuracy may be looked for; but even so, when consideration is taken of the number of variables contained in the basis used for estimating, a doubt always remains as to the accuracy of the result. Outside of the effect which mean pressures or the number of revolutions have upon the weight per I. H. P., other disturbing elements have to be taken into account; for example, machinery developing

Formulæ for Estimating Weights of Machinery.

ENGINE-ROOM WEIGHTS.

D = sum of the squares of diameter (in inches) of each cylinder directly connected to cranks.
d = sum of the squares of diameter (in inches) of the upper cylinders of tandem engines.
L = length of stroke (in feet).
n = number of sets of engines.

Screw propeller engines for war vessels:

Launches, pinnaces, torpedo-boats, destroyers, and torpedo gunboats. — Wt. in tons = $.25n\sqrt{DL}$

Battleships, 1st, 2d, 3d class cruisers, gunboats, and commerce destroyers. — Horizontal engines..... Wt. in tons = $.04n[(DL)^{\frac{2}{3}} + 375]$; Vertical engines..... Wt. in tons + $.052n(DL)^{\frac{2}{3}}$

Screw propeller engines for mercantile vessels:

Launches and other small boats..... Wt. in tons = $.27n\sqrt{DL}$

Steamers of all classes, including yachts..... Wt. in tons = $.018n[(DL)^{\frac{7}{8}} + 390]$

Side-wheel engines for mercantile vessels:

Oscillating surface condensing..... Wt. in tons = $.4n\sqrt{DL}$

Diagonal surface condensing..... Wt. in tons = $.35n\sqrt{DL}$

NOTE.—In estimating weight of tandem engines $(DL + \frac{d}{2})$ should be substituted for (DL) in above formulæ.

*From a paper read before the Society of Naval Architects and Marine Engineers, at the Fifth General Meeting.

3,000 I. H. P. may be installed in a vessel 250 ft. long engaged in a short-run service, and a similar set of machinery, developing likewise 3,000 I. H. P., may be fitted in a vessel 400 ft. long engaged in trans-ocean trade. In the latter case, apart from minor differences in the smaller details of the machinery, the increase in length of shafting, and accompanying increase in the num-

SHAFTING, ETC.

Screw propeller shafting:

$D^2 L$ = sum of [diameter^2 (inches) × length (feet)] of crank + thrust + line + propeller shafts.
$d^2 L$ = sum of [diameter^2 of hole (inches) through shaft × length (feet)] of shafting.

Solid shafting ..... Wt. in tons = $.0026\ D^2 L$.
Hollow shafting ..... Wt. in tons = $.0026\ D^2 L - .0012\ d^2 L$.

Paddle engine shafting:

D^2 = mean diameter^2 of crank and paddle shafts (inches).
d^2 = diameter^2 of hole through shafts (inches).
L = beam of vessel + length of one float (feet).

Solid shafting ..... Wt. in tons = $.003\ D^2 L$.
Hollow shafting ..... Wt. in tons = $.003\ D^2 L - .0012\ d^2 L$.

SCREW PROPELLERS.

D = diameter of propeller (feet).
S = surface of propeller (sq. feet).
n = number of propellers.

Steel or bronze, with detachable blades:

	3-bladed.	4-bladed.
When value of $D\sqrt{S}$ is below 50 ..... Wt. in tons =	$.031n\ D\sqrt{S}$	$.028n\ D\sqrt{S}$.
When value of $D\sqrt{S}$ is above 50 ..... Wt. in tons =	$.11n\ (D\sqrt{S} - 36.3)$	$.1n\ (D\sqrt{S} - 40)$.

Cast-iron propellers 20% greater weight than above.
Steel or bronze solid propellers 25% less weight than above.
Cast-iron solid propellers 10% less weight than above.

PADDLE WHEELS.

D = diameter of wheel to axis of floats (feet).
L = length of float (feet).
P = indicated horse-power.
N = number of floats on one wheel.

$C = DLP \div 100N$.

Feathering floats:

When value of C is below 75 ..... Wt. in tons of 2 wheels = $.18C$.
When value of C is above 75 ..... Wt. in tons of 2 wheels = $.06C + 8.5$.

NOTE.—Wt. obtained includes gear for feathering floats.

Radial floats:

When value of C is below 75 ..... Wt. in tons of 2 wheels = $.17C$.
When value of C is above 75 ..... Wt. in tons of 2 wheels = $.054C + 8.5$.

BOILER ROOM WEIGHTS.

D = mean diameter of Scotch and Navy (low cylindrical) types, and of the barrel of locomotive boilers (feet).
L = length, over end plates, of all types (feet).
HS = total heating surface of one boiler.
TS = tube heating surface of one boiler.
N = number of boilers of each type.
d = diameter of tubes (inches).
l = length of tubes (feet).
f = mean diameter of furnaces.
n = number of furnaces in one boiler.
$\pi = 3.14$.

$$A = \frac{HS \times d}{12\ \pi} + nf^2 l,\quad B = \frac{HS \times d}{12\ \pi} + nf^2 (L - l),\quad C = \frac{TS \times d}{12\ \pi}$$

MAIN BOILERS, ETC.*

Scotch boilers:

Single ended ..... Wt. in tons = $.0085N\ [D^2 (L + 2) + HS] + 10N$.
Double ended ..... Wt. in tons = $.0093N\ [D^2 (L + 2) + HS] + 5N$.

Navy (low cylindrical) boilers:

Single ended ..... Wt. in tons = $.0085N\ [D^2 (L + 2) + HS] + 5N$.
Double ended ..... Wt. in tons = $.0085N\ [D^2 (L + 2) + HS]$.

Locomotive Boilers ..... Wt. in tons = $.011N\ [D^2 (L + 2) + HS] - 5N$.

WATER IN MAIN BOILERS.

Scotch boilers:

8 inches above top row of tubes ..... Wt. in tons = $.0117N\ (D^2 L - A)$.

Navy boilers:

6 inches above top row of tubes ..... Wt. in tons = $.0099N\ (D^2 L - B)$.

Locomotive boilers:

6 inches above furnace crown ..... Wt. in tons = $KN\ (D^2 L - C - 125)$.

*The weight of main boilers as given by formulæ includes the weight of plain tubes; where Serve tubes are used an increase determined as follows: $\frac{HS \times 3}{2240}$ = tons increase, should be added to totals.

Values of K in formula for weight of water in *locomotive boilers:*

Boilers with dry bottom and one furnace K = .028.
Boilers with dry bottom and two furnace K = .030.
Boilers with wet bottom and one furnace K = .032.
Boilers with wet bottom and two furnace K = .034.

NOTE.—Tons per inch at above levels of water = approximately $.0021\ DL$.

AUXILIARY BOILERS AND WATER.

Auxiliary boiler and water (horizontal and vertical types) ..... Wt. in tons = $.031ND^2 L$.

ber of journals, etc., probably a larger propeller, loftier funnels and uptakes, have a certain effect on the weight per I. H. P., and it is very doubtful whether, in selecting a coefficient of weight for use in a new design, due allowance is always made for these disturbing elements. It is good practice, in both the hull and engine departments, to make a second and final estimate of weights as soon as possible after the dimensions have been finally decided upon and before the actual work in the shops is commenced. As in the first approximation, each designer has his own method of making the final or check estimate, some preferring to make a direct estimate, computing the weight of each part of the structure separately. This method is open to several objections, chief among which is the time and labor involved and the general unreliability of the result, this last objection arising from the observed fact that no matter how experienced the computer may be, or how familiar he may be with all structural details, the chances are against him of his covering all the ground in the small and varied minutiæ of detail fittings, etc., the tendency being strongly in the direction of underestimating.

The preferable method is to take the recorded detail weights of machinery already constructed and distribute them under several heads or subdivisions, the total of each subdivision to be gauged or measured by that dimension or other salient feature of the structure which exercises a controlling influence on the detail weights forming each particular subdivision. By some such system full advantage is taken of past experiences, and the small details are well taken care of under the different heads, producing a more reliable result with less expenditure of time and labor than by the direct method.

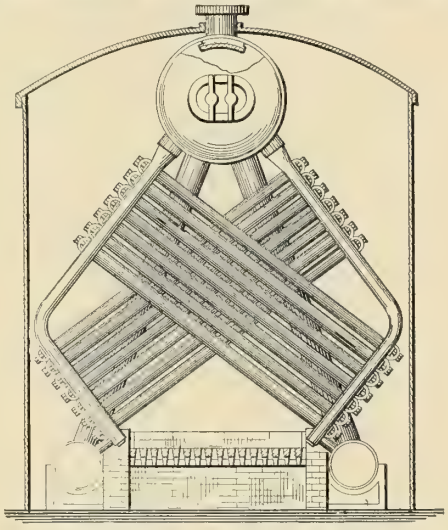
Two important war vessels for a foreign government were launched last month from American yards. The Japanese cruiser Kasagi went into the water at Cramp's yard January 20, and two days later the cruiser Chitose, for the Japanese Navy also, was launched at the Union Iron Works in San Francisco. These vessels are very similar in design, and are rated as second-class protected cruisers. They are nearly 400 ft. long and about 4,800 tons displacement. Both vessels will have high speed and will be supplied with heavy batteries of rapid fire guns. The importance of these contracts is apparent when it is recollected that they were secured in open competition with the world's shipyards.

The White Star liner Britannic recently completed her five hundredth voyage across the Atlantic. She is an iron single screw vessel of about 5,000 tons built in 1874. During this period she has steamed 1,500,000 miles, and burned 513,000 tons of coal. She is still fitted with the original machinery.

IMPROVED APPARATUS.

Carpenter Marine Water-Tube Boiler.

In this boiler the headers are of peculiar construction. The upper ends, where connection is made with the drum, are round in section, but where the tubes connect the section is a parallelogram with round covers. In one side of this tubular header the generating tubes are entered and expanded, and in the opposite side there is a hand hole with removable cover to permit of easy cleaning or renewal. In the marine type the generating tubes run diagonally across the furnace chamber in two oppositely inclined nests.



CARPENTER WATER-TUBE BOILER.

The headers are bent at an obtuse angle so that the tubes connect the upper and lower ends of opposite headers, and there is sufficient room for grate space between. The down pipes are of large bore and connect with two horizontal pipes on a level with the fire bars. It will be noticed these down pipes are carried inside the casing and are exposed to the action of the gases. This boiler is the invention of Prof. R. C. Carpenter of Cornell University, who is also the patentee.

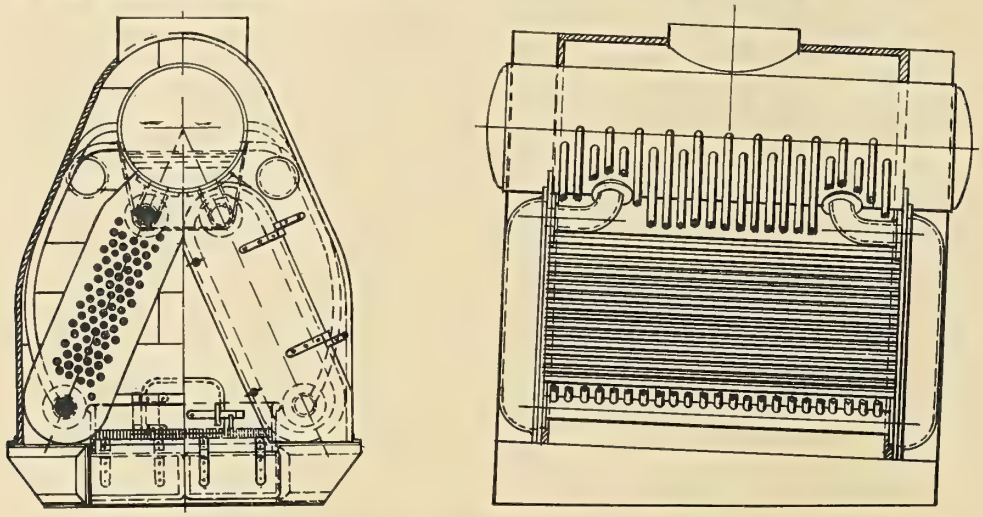
Lumgair Water-Tube Boiler.

A new form of water-tube boiler patented by David Lumgair is shown in the engravings on the next page. It consists of a combination of straight horizontal tubes and vertical bent tubes. The former connect the upright headers, placed A shaped over the grate. At the bottom the headers are connected by large horizontal pipes, and at the tops connections are made with the drum by nozzles. The vertical down pipes connect the drum with the large pipes connecting the lower ends of the headers. The grate is placed in the center, the gases passing between the tubes on each side and over the drum to the stack. There are no bolts or nuts exposed to the fire. The heads are fitted with doors to give access to the interior to the tubes, for ready examination or cleaning. A baffle plate is fixed

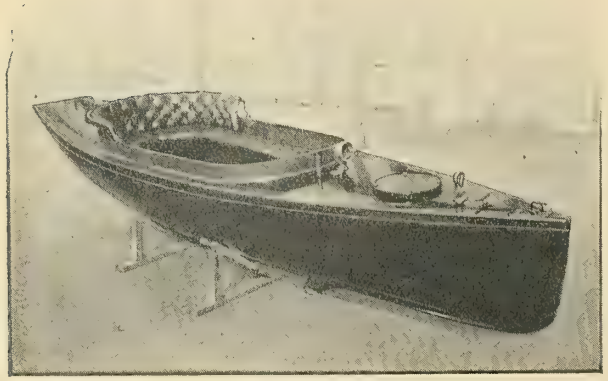
over the tubes and carried up on each side of the drum. David Lumgair, of West Bay City, Mich., is the inventor and patentee.

Electric Gig for Yacht Equipment.

The engraving shows an electric gig recently shipped by the Electric Launch Co. of New York to the Austrian Baron Rothschild at Trieste. This boat is to form part of the equipment of the Baron Rothschild's palatial steam yacht Veglia. It is one of the most finely finished boats of this type ever constructed. The dimensions are: Length over all, 25 ft.; beam, 6. ft.; depth, 3 ft., and length between hoisting shackles, 19 ft. 2 in. There is seating space for fifteen persons and it will be noticed that this is not encumbered with any apparatus or propelling machinery. The motive power, which consists of a set of storage batteries supplying current to a motor attached to the screw shaft, is out of sight. The motor is placed under the grating amidships and the secondary batteries under the seats. The regulation of power and steering is affected by one man, who, by moving suitable levers, can go ahead or astern or vary the speed of the motor. There is, of course, an agreeable absence of noise, heat, or odors during the running of the boat. On trial a regular speed of 6.84 miles was attained. The batteries will be charged from the electric light plant on the owner's yacht, which furnishes light for 400 lamps. When charged they will last for a four hour run. The company, which has its works at Morris Heights, is now at work on a similar, though larger, boat for the Czar of Russia.



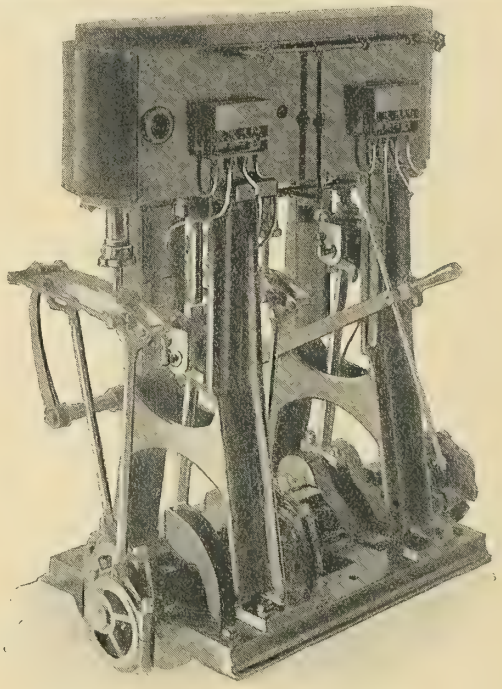
SECTIONAL SKETCHES OF LUMGAIR WATER-TUBE MARINE BOILER.



ELECTRIC GIG FOR BARON ROTHSCHILD.

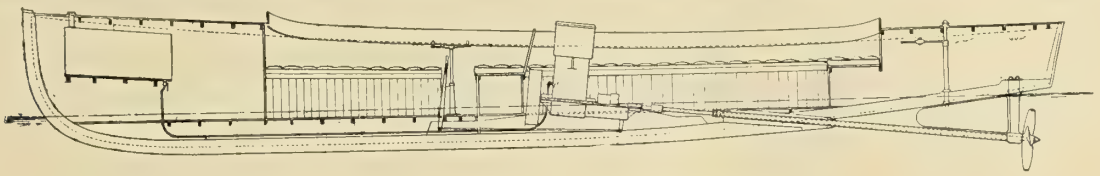
Twiss Vertical Marine Engine.

A standard type of engine built in various sizes, both compound and triple, is shown in the engraving of the Twiss marine engine. The design is simple, the material used is good, and as the wearing surfaces are large the engine is a



TWISS VERTICAL MARINE ENGINE.

successful machine. The crossheads work in slides which are bored out when the cylinders are in place on the columns, so that a high degree of accuracy is secured. Piston valves are used with Stephenson adjustable link motion. A feature of the design is the method of securing the reversing lever which is held to a guide rod by a binding screw and hand wheel. The cylinders are lagged in sheet iron, the tops being made to slip off readily, allowing ready access to the covers. The engine is built by Nelson W. Twiss, New Haven, Conn.



LONGITUDINAL SECTION OF KING MOTOR BOAT.

Improved Type of Motor Boat.

The ordinary motor boat is frequently of cumbrous build, clumsy and wasteful of power, a row boat in fact, with an engine in the stern. The illustrations here show a boat built by the Charles B. King Co. upon the lines which govern the construction of modern, small, high-speed boats. The sectional sketch shows that the dead wood is entirely cut away and is replaced by the rudder, which is forward of the wheel. The position of the rudder makes it little liable to damage, and at the same time the maneuvering powers of the boat are not impaired. The 33 ft. boat of this type, fitted with an engine rated at 6 H. P., is guaranteed by the builders to attain a speed of 10 miles an hour, the control of the boat being in the hands of one man. The design of engine built by the company is seen in the engraving on this page. It is of the two cylinder type, an impulse being given at every other turn in each cylinder. Reversing is carried out in the gear attached to the engine, so that the use of a propeller with reversible blades is avoided. The cranks work in an enclosed chamber, which is partially fitted with oil so that the main bearings and cylinder are lubricated automatically. Starting is effected by withdrawing the relief rod and turning the fly wheel, two revolutions being usually sufficient. The relief rod is then pushed in and the engine is at work. Electric igniters of carefully designed pattern are used. Gasolene is used in the motor. The engine, rated at 6 H. P., weighs 700 pounds. Additional particulars regarding these motors and boats, and a trial boat now in operation on the Detroit river, can be had on application to the builders, the Charles B. King Co., Detroit, Mich.

KING MOTOR BOAT AND GASOLENE MARINE ENGINE.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative,
S. W. ANNESS,
Philadelphia, Pa., Bourse Bldg.

Western Representatives.
L. L. CLINE & CO.,
Detroit, Mich., 47 Hodges Bldg.;
Chicago, Ill., 305 Fisher Bldg.

Traveling Representatives,
E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:
Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

WITHIN a comparatively short time vast progress has been made by naval architects and engineers in the construction of extremely high speed vessels. It is to strictly naval, as distinguished from mercantile, needs that this progress is due in greatest measure. The evolution of the torpedo boat from a fast launch to the present seagoing destroyer—which is very ably and concisely stated by H. G. Gillmor, U.S.N., in his paper published in our last issue—has called attention to the possibilities in the way of speed more clearly than any other agency. This knowledge and advancement could not have been gained in purely mercantile practice in a very much longer space of time, if at all, for commercial reasons. The rivalry of governments and the exchequers of nations, however, furnished the stimulus and the means by which present conditions have been reached. Latest in the list of extraordinarily high speed vessels is the Mosher launch Ellide, 80 ft. long with engines of 800 horse power, which, on trials in the Hudson river, covered a mile at the rate of 37.89 miles an hour. Ascending the scale in points of size and power, next comes the torpedo-boat destroyer Express, lately launched by Laird Bros., of Birkenhead, which is guaranteed to have a trial speed of 33 knots or about 38 land miles an hour. This boat is 235 ft. long, 400 tons gross register, and is fitted with engines of 10,000 indicated horse power. Going up another step the mail steamer Connaught, which carries the American mails across the Irish Channel, has a sea speed in excess of 23 knots, day-in-and-day-out. She is 380 ft. long and is fitted with twin-screw engines of about 9,000 indicated horse power. At the top in point of combined size and speed is the North German Lloyd liner Kaiser Wilhelm der Grosse 648 ft. long, of 14,000 gross tonnage, and with a speed record of 22.83 knots, for a full twenty-four hours. All these vessels are fitted with reciprocating engines, with boilers, in the two smaller of the water tube type, and in the two larger, of the cylindrical return-tube type. There is, of course, the 100 ft. boat Turbinia fitted with Parson's steam turbines of 2,500 horse power; but she must as yet be considered an experiment, whereas the others have been built under contract in the ordinary course of business. There are many war vessels afloat with phenominally high speeds, but it is doubtful in most cases if, with the shifting around of trained crews and the few opportunities afforded for practice in continuous high speed runs, they could repeat their trial performances. It is a popular mistake, however, to imagine what we now consider extreme speeds are easily reached and maintained. Only those who are concerned realize the tremendous care necessary in design and construction and the watchfulness and anxiety occasioned to get the results. Railroad speeds may have been reached, but not railroad ease, and cushioned seats, though common enough in locomotive cabs, are not yet part of the equipment of the high-speed marine engine room.

RECENT severe losses, the falling off of river trade, and increased competition, are given as the reasons for the assignment made by the St. Louis and New Orleans Anchor Line. This was made last month to Archibald Woods, an employe of the company, for the benefit of creditors, the assets including steamboats, barges, stock-in-trade, elevators, landing and other property of the company, valued at $98,600. The necessity for such action is much to be regretted as for many years, since the war time in fact, this line has worthily upheld the traditions of Mississippi river steamboating. Not only in the prosaic records of trade, but in song and story the magnificence of the great floating palaces of the Father-of-Waters has been recorded in many tongues. The skill of their pilots, the audacity of their engineers, the luxury of their equipment and service are of world-wide renown. It was in

the sixties that the Anchor Line was formed by a consolidation of short lines touching at various points between St. Louis and New Orleans. A policy of progress was at once commenced, all the old boats being sold or broken up and replaced by finer steamers. Traffic on this route was practically uncontested until the year 1880 when a rival company was organized to operate a tow barge line for handling freight. The railroad building craze which caused the construction of parallel railroad lines also cut into the trade of the company, especially for fast through business. It was during the past two years, however, that the most disheartening and disastrous losses occurred. The cyclone of May 27, 1896, wrecked three of the company's finest steamers, the Arkansas City, City of Cairo, and the City of Monroe, making a loss of about $150,000. In the month of August, following, the steamer City of Hickman, a grand river boat costing $100,000, struck a snag and was lost. Ill luck followed the company closely last year. In the fall the steamers Belle Memphis and Mary Morton were lost by striking snags and $40,000 was written off, and November 18 the new and palatial steamer Bluff City burned to the water's edge, adding $75,000 to the already large total of losses.

UNOFFICIAL figures of British shipbuilding returns for 1897, which have appeared in various foreign marine publications since the close of the past year, show a falling off from the total for 1896. The various authorities, of course, do not agree exactly as to the totals, but an average of the amounts given show a grand total for all private yards of 1,100,000 tons, and this is probably not far from the exact figures. The decline is very generally mourned by the British papers and is unanimously attributed to the great engineers' strike, which prevented the completion of many vessels on the stocks and had also the effect of sending orders to the continent of Europe which would otherwise have been placed in British yards. The falling off is estimated by some of the authorities to be as high as 250,000 tons, but how this total is made up is not apparent, when a comparison is made with the figures for 1896 given out some time ago by Lloyd's Register. These gave a total for 1896 of 1,121,505 tons, which would show a decrease for 1897 of only 20,000 tons in round numbers. An examination of the figures now given for 1897 shows that the relative positions of the leading builders are not much changed from the preceding year. The firm of Harland and Wolff, of Ireland, again heads the list with a total of 84,240 tons. Next comes the English east coast yard of C. S. Swan and Hunter with 48,570 tons and fourth in the list the top figures for a Scotch yard are reached with 42,913 tons for Russell and Co., of Port Glasgow. The total for Harland and Wolff was made up last year as before of large vessels exclusively, ranging from the White Star freight steamer Cymric of 12,340 tons, for the New York-Liverpool trade, to the smallest steamer of 4,582 tons.

THE members of the Marine Engineers' Beneficial Association held their annual convention at Washington, D. C., January 18 to 21. About forty delegates were present, representing local associations all over the country, both on the coasts and lakes, places as widely apart as San Francisco being represented by Vice-President Jones, Duluth by A. McGillivray, Galveston by John A. Cotter, and Pensacola by James L. Sweeney. The meeting was presided over by President George H. Uhler, who has ably served the Association for many years and who was unanimously elected for the ensuing year. Secretary Thomas F. Dowd, of Chicago, was also in attendance. The sessions were private. Business to be transacted included the discussion of reports, appointment of committees, and the discussion of various matters affecting the welfare of the members of the Association, and in fact all who occupy positions as engineers of vessels. A matter of importance which received much attention was the proposition of some of the members to establish a paper to be devoted to the interests of the Association. A representative of Marine Engineering was requested to submit a proposition to a committee of the whole. This was debated and finally referred to the Committee on Publication. The convention received the captains and pilots on Thursday evening, January 20, at 6 o'clock, and also the Board of Supervising Inspectors, which was holding sessions at this time. This was in accord with a long established custom, as the relations between these bodies are very harmonious. The Marine Engineers' Beneficial Association is purely fraternal and beneficial, rendering brotherly assistance among its members, and paying death and disability benefits.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

The annual meeting of the American Society of Naval Engineers was held in Washington, D. C., January 7 and 8.

This year, for the first time, the society held meetings for the reading of papers and the general discussion of naval engineering topics. On previous occasions the members have met together simply to elect officers, and the society has published papers in its excellent journal which appears quarterly.

First Day, Friday, January 7.

On the opening day the meeting was called to order in the hall of the Columbian University, Friday afternoon, January 7. In the absence of the President of the Society, Chief Engineer Smith, Chief Engineer H. Webster was called upon to preside. Mr. Webster welcomed the visiting members, and read a letter from Engineer in Chief George W. Melville, U. S. N., in which he regretted that he was unable to be present at the meetings, he having been called to the Capitol on departmental business. The report of the council was then read by the secretary, Past Assistant Engineer F. C. Beig; it was a brief statement relating to the affairs of the society, and informed the members that a button or badge for the society had been decided upon, a roseate of gold and red. He informed the members that the council had, after carefully going over the papers submitted, presented the yearly medal to Passed Assistant Engineer W. W. White, for his paper designated "Facts, Not Fiction," its subject being "Steam Consumption of the Main and Auxiliary Machinery of the U. S. S. Minneapolis."

After the reading of the report, the presiding officer congratulated Mr. White upon his very admirable treatise, and presented him with the society medal.

Mr. White, who was very warmly welcomed, then proceeded to read his paper, which we shall publish in an early issue. The paper called forth quite an animated discussion. F. W. Wheeler, of New York, discussed the paper at length, and pointed out that some of the auxiliaries were working under disadvantages. He very strongly urged the advisability of using the exhaust steam from all the auxiliaries for feed water heating, and stated that considerable saving would be effected in this way. He also thought that the time had come when more attention should be paid to the design of the auxiliaries themselves, and urged compounding.

It was afterwards pointed out by a number of the officers of the Navy that it was almost impossible to fit feed water heaters in the naval vessels for lack of space.

The second paper was upon "American Steam Yachts," by Irving Cox, of New York. Mr. Cox deplored the fact that so many Americans went abroad for their vessels instead of having them built at home; he did not think that American yachtsmen treated the designers at all fairly. They asked for a great deal more speed in a given sized boat than the English builders would give them, and then were surprised that such boats cost more money. The paper contains some interesting figures with regard to the maintenance of a first-class yacht, the cost for a cruising yacht being from $3,600 to $4,000 per month.

Two papers were then read by the secretary, the authors not being present. These were: "Tests of the Niclausse Safety Water-Tube Boiler," by J. M. Whitham, of Philadelphia, and "Water-Tube Boilers," by Darwin Almy, of Providence, R. I. These papers were discussed together, and called forth a good deal of remark. The discussion was taken part in by Passed Assistant Engineer Walter M. McFarland, who has written much on this subject. He pointed out the fact that it was necessary that a great deal more attention should be paid to the details of construction, and also stated that because in the Navy they had to use very high pressures, the water-tube boiler had become a necessity.

Charles Ward, of Charleston, spoke of the great development that had taken place in water-tube boilers in the last few years; he advocated the building of the boilers in such a way that they could be easily inspected and repaired. He strongly deprecated the use of boilers with tubes that were nearly horizontal.

John Platt, of New York, spoke at length on the general subject. He advocated the building of water-tube boilers with "boiler making" details instead of those of the steam engine builder, as is done at present by many builders. He pointed out that a marine water-tube boiler, to be good, should be capable of the very highest degree of forcing. That when so forced the economy should not run down rapidly and the uptake temperature should be low. That boilers were in service in which this was possible, and if these were compared with the Scotch boiler, then the economy would not be on the side of the old type of boiler.

Jarvis B. Edson, of New York, spoke as a yacht owner, and pointed out that his fellow yachtsmen were on the lookout for an economical boiler which would not have to be laid up for repairs the greater part of the time.

A number of the other members took part in the discussion, the general tenor of their remarks being that the water-tube boiler must now be looked on as the one for use in the new naval vessels.

The next paper was read in person by David P. Jones, on the subject of "Boiler Testing with Various Fuels." This paper is of great value, as it gives the result of the burning of many different kinds of coal. It should act as a warning to the boiler man not to make a guarantee on evaporation without taking the kind of coal into account. The paper called forth a good deal of general discussion.

In the evening the members of the society held a business meeting in the rooms of the Chief of the Bureau of Steam Engineering in the Navy Department. The secretary-treasurer's report showed a fair increase in membership for the year, and also that the financial condition of the society was very good. Officers for the ensuing year were then elected, as follows: President, Chief Engineer Harry Webster; Secretary-Treasurer, Passed Assistant Engineer W. M. McFarland; Members of Council, Chief Engineer F. W. Baird, Passed Assistant Engineer W. W. White and Passed Assistant Engineer E. Theiss.

Second Day, Saturday, January 8.

On Saturday morning at 10 o'clock the members met at the office of Chief Engineer Baird, in the State Army and Navy Building. A photograph of the group was first taken, and then the members visited the Congressional Library, and from there they went on to the Washington Navy Yard and inspected the gun shops. At 2 o'clock in the afternoon the meeting was again called to order in the Columbian University Hall. The first business was the discussion of Mr. Jones' paper on "Boiler Testing;" after this, a paper on "Speed of Construction," a vital factor in naval strength, was read by Frank B. King, of Washington. This paper was a very prolonged letter, and advocated very radical changes in the methods of the construction of ships. The author advocated the adoption of bridge building methods in ship building, and pointed out that if care was taken to so design vessels that reproducing methods could be used, then the time of production would be cut down very materially. This was followed by a paper by Col. E. D. Meier, of St. Louis, on the Diesel Motor." The speaker seemed to think that in the very near future this motor would be used in very large sizes in marine work. It is an improved oil engine, invented by a German engineer. From the results of tests given, the engine is undoubtedly a good one, and in-

teresting developments may be looked for in the near future. It is claimed that a higher efficiency has been obtained with it than with any other heat engine, whether it be steam, gas or oil.

The last paper read was on "Oil Fuel Trials on the Lifeboat Queen," by John Platt. This paper describes in full the hydraulic lifeboat which was illustrated and described in our January issue, and further gives the result of oil fuel trials made on the Thornycroft boilers of the boat. After the discussion of this paper the following papers were read by title:

"The Submarine Boat Plunger," by J. Alvah Scott, of Baltimore.

"Entropy and Temperature Entropy Diagrams," by Prof. W. F. Durand, of Ithaca, N. Y.

"The Status of Boards on Changes as Usually Constituted Under the Contracts for the Construction of Our New Navy," by W. W. Varney, of Baltimore.

"Propulsive Power," by James N. Warrington, of Chicago.

After the usual vote of thanks, a very successful meeting was brought to a close. For a first venture the meetings were undoubtedly a success. Another year, with more time at the disposal of the officers of the society, great things may be expected and a very much larger attendance.

Though this was the ending up of the business of the convention, the social side included the First Annual Banquet of the society, which took place on Saturday evening at the Maison Rauscher. A Washington paper reports that "the dinner in itself was one of the most elaborate and elegant ever given at Rauscher's, while the informal speeches of the evening were bright and appropriate." John C. Kafer, of New York, acted as toast master. He made a very neat speech of welcome, in his usual affable manner. Informal speeches were made by Jarvis B. Edson, Col. E. D. Meier, Passed Assistant Engineer F. C. Bieg, Passed Assistant Engineer W. M. McFarland, Chief Engineer Baird, Chief Engineer Robie and others.

Fatal Explosion on Ohio River Steamer.

An explosion on the Ohio river steamboat Percy Kelsey killed five and injured eight of the crew, besides wrecking the boat. She was towing nine coal barges to Cincinnati, and when just below Glenfield station on the Pittsburg, Fort Wayne and Chicago Railway, shortly before noon of January 8, the explosion occurred without the least warning. Robert J. Davis, the chief engineer, who was on duty in the engine room, and who was among those not injured, said afterward that there was plenty of water in the boilers at the time and all the apparatus was working effectively. He had just made an inspection of the machinery in readiness to turn over to the assistant engineer, who was about to come on watch. The boat was completely wrecked, as will be seen in the reproduction of the photograph, which was taken for the Pittsburg Despatch soon after the explosion. A terrific report accompanied the explosion and many of the windows in the houses in Glenfield were shattered, which was also bombarded by portions of the machinery and wreckage. One section of the boiler 10 ft. long was carried some distance from the river bank before it fell. Many of the crew were frightfully torn and disfigured, and several of those not killed outright were not expected to recover.

The boat, which was built in Pittsburg in 1882 by W. H. Brown's Sons, was 148 ft. long, 31 ft. beam and 4 ft. 8 in. deep in the hold. Her carrying capacity was 245 tons. She had four boilers and the usual form of river stern-wheel engines. Three of the boilers had been in the boat since she was built and the fourth had been put in in 1886. She had been regularly inspected by the Government inspectors, the last inspection having been made in May last. She was valued at $40,000, but is said to have carried no insurance. The barges which the steamboat was towing were not damaged.

CORRESPONDENCE.

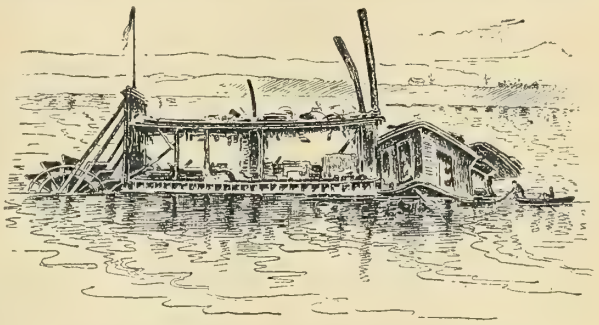
[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Regarding the Position of Screw Propellers.

In reply to your correspondent who asks regarding the arrangement of twin screw propeller shafts (in the January issue), it may be first pointed out that the case most commonly found is that in which the shafts are farther apart at the propellers than at the engines. This is due, however, not to considerations relating to the performance of the propellers, but rather to considerations involving various questions of structural arrangement in connection with the form of the after body of the ship. In the usual case the disk circles of the propellers do not overlap, but are separated by 1 or 2 ft. or more, depending on circumstances. The distance between the shafts at the propellers is thus approximately fixed by the diameter of the latter. Passing forward to the engines it is not usually found feasible or desirable, having due regard to a compact arrangement of machinery, to place the shafts as far apart as at the stern. Especially in narrow vessels or those with considerable rise of floor, there would be insufficient room outboard for the necessary arrangement of the machinery, including auxiliaries, pipes, outboard valves, etc., while an unnecessary amount of room would be provided between the two engines. The latter are therefore naturally moved toward the center line, thus giving a divergence to the shafts from forward aft. This has the further advantage of running the shafts through the ship's side at a more favorable angle than if they were parallel to the keel, or converged from forward aft. It is readily seen that with parallel shafts or with a slight convergence, they might, with fine after body, be so nearly parallel to the skin of the ship that the structural disturbance attendant on carrying the shafts through the skin would be much greater than with a slight divergence as in the usual case.



STEAMBOAT PERCY KELSEY AFTER THE EXPLOSION.

We may now turn to the considerations involved in the action of the propellers. The water in closing in behind and under the ship follows to some extent the form of the after body, and hence the streams on either side converge from forward aft. It follows that with shafts parallel to the keel the propellers will work in a stream flowing oblique to the shaft upon which they revolve. It may be shown geometrically that this gives rise to a variation of slip during the revolution of a given blade, more and more pronounced as the obliquity is greater. The result of this variation of slip is an irregularity in the resistance to the movement of the blade, a consequent tendency to irregularity of motion, and a loss of efficiency due to working over a wide range of slip in-

stead of at a nearly constant value. It is also evident when the shafts diverge from forward aft, as in the usual case, that the obliquity of flow of the stream relative to the propeller will be still greater, and the effects above noted will be still more marked. For smoothness and efficiency of operation, therefore, the propeller shafts would rather be made to converge from forward aft so as to bring them more nearly parallel with the average lines of stream flow. These considerations are therefore directly opposed to those relating to structural arrangement, as above referred to.

Another consideration bearing on the question has relation to manœuvering power. With the shafts parallel it is evident, if one propeller is turned ahead and the other back, that a pronounced turning moment or effort will be produced. If, however, the shafts diverge from forward aft at a considerable angle it may be that their lines of action if continued forward would meet and cross at about the center of resistance to motion. In such case if one engine is turned ahead and the other astern, the ship will simply sidle off crabwise, without definitely turning in either direction. If in an extreme case the lines of action should cross aft of the center of resistance, the turning effect would be the reverse of that in the usual case. It follows that parallelism or a convergence from forward aft would be favorable to a pronounced turning effort, and while this is not usually feasible, care should be had that the divergence from forward aft is not so great as to seriously interfere with the manœuvering power of the screws.

With regard to the angle of drop in a single screw shaft, the same general considerations apply. The inclination is usually due to structural reasons, or to the necessity of getting sufficient immersion for the propeller. It gives rise to a periodic variation in the slip, and tends to produce irregularity of motion and loss of efficiency, though only in small degree with the usual angles. As a further point bearing on both single and twin screw shafts, mention may be made of the loss due to the obliquity of the shaft to the line of motion. The thrust considered as exerted along the line of the shaft is not in the direction of motion, but slightly oblique, and thus introduces a loss, though very slight in all usual cases. A loss of 1 per cent would correspond to about 8 deg. inclination, or a slope of one in seven.

Again, with single screws working on a shaft sloping down from forward aft, the thrust tends to lift the stern somewhat, and thus, as far as it may go, this influence will antagonize the change of trim or squatting of the stern so commonly met with in small boats at relatively high speeds.

It is readily seen from the preceding brief mention of some of the more important considerations entering into this question, that like all others in engineering it is one involving many antagonistic considerations, and that any solution must necessarily be in the nature of a compromise between them.

W. F. DURAND.

In Further Discussion of Walschaert Gear.

In regard to my request published in your November issue for a diagram of the Walschaert valve gear, I have noted the reply to the same in your January number, signed C. H. Peabody. His reply, however, does not cover the entire question, as he simply confirms the conclusion that it is impossible to construct a diagram of this gear, or any radial gear, and that the only way to study it is by means of a model, or in other words, by a system of trial and error. His sketch showing the gear as applied to locomotives is essentially the same as that shown for marine use. My idea of a diagram for this gear is one in which the variations of release and compression may be shown in a general way for different degrees of linking in, without any definite sizes being used, also the effects of linking in. H.

The Turbinia and Her Performances.

Seeing the great interest that seems to be aroused by the performance of the "Turbinia," it might prove of interest for your readers to have an unbiased analysis of a professional torpedo-boat designer on the performance of the Turbinia, and more important, on the causes that contributed to the marvelous speed she attained. Having been in charge of the construction of U. S. torpedo boat Ericsson I might use that vessel for comparison and also in some way the performance of Mr. Mosher's "Ellide" as a high-speed boat fitted with reciprocating engines.

Let us assume for the sake of convenience that the Turbinia made 30 knots on the measured mile. Such speed on about 44 tons displacement would require about 2,340 I.H.P., assuming an Admiralty constant of 164 for the formula.

$$\text{I.H.P.} = \frac{V^3 \times D^{\frac{2}{3}}}{C} = 2340$$

which probably will be near the actual power.

We will have to consider the three phases of propulsion and their efficiencies separately and try to find which mainly contributes to the success of the boat:

First Phase: Generation of steam in boiler.

Second Phase: Transformation of steam energy into rotation of shafting and propellers through the engines.

Third Phase: Transmission of motion to hull through action of propellers on water.

Now Mr. Parsons attributes the success of the boat to an improvement in the second phase—substituting turbines for reciprocating engines—while I consider that certain features of the first and third phases are the only real causes for the high speed attained. The turbine engines appear to me as of subordinate importance and comparatively little commercial future for marine propulsion.

The notable feature of the third phase is, applying successfully small propellers revolving at over 2,000 revolutions to marine propulsion, in an arrangement of three propellers on one shaft, and we are indebted to Mr. Parsons for publishing his observations and experiments on cavitation caused by quickly revolving screws.

The most important feature responsible for the success of the boat is the one of the first phase, viz., driving a small boiler at such excessive rates of coal consumption and evaporation, as in the Turbinia, about 2,340 I.H.P. from about 1,100 sq. ft. heating surface and about 42 sq. ft. grate surface, under about 7 in. of air pressure were obtained, something enormous for marine conditions. This means about 56 I.H.P. per sq. ft. of grate and at least 120 lbs of coal per hour per sq. ft. of grate. This consumption has been equaled only in locomotive boilers, formerly used in torpedo boats, but now discarded for water-tube boilers burning a maximum of 50 lbs. of coal per hour per sq. ft. of grate and about 2 in. air pressure, as exemplified in the Ericsson. Such excessive combustion as in the Turbinia is considered by the best authority impractical, except for show purposes, the coal consumption being wasteful and combustion anything but good. Then an allowance of only 1,100 sq. ft, heating surface for double the number of I.H.P. is considered entirely inadequate for transmitting such an amount of heat to the water. The allowance in the Ericsson of nearly 4,700 sq. ft. heating surface and 85 sq. ft. grate surface for 1,800 I.H.P. indicates the experience of different navies, that consider also the question of durability, safety and immunity from break downs. "Turbinia" practice can be only executed in an experimental boat, where all considerations of economy, safety and commercial practicability are sacrificed to the one item of speed. We will have to wait quite a while before we see any conservative navy subject its torpedo boat boilers to such an ordeal of stress, combined with such wasteful expenditure of coal. Especially in batteries

of large sizes boilers under such treatment would be ruined in a short time.

To attain excessively high speed we need no turbines, as Mr. Mosher has proved lately with the Ellide with a trial speed of more than 30 knots and regular reciprocating engines under the advantage of efficient reversibility, lower number of revolutions and more general accessibility, that offset manyfold the advantage of turbines—no reciprocating parts, higher expansion rates and slightly decreased weight.

Summing up, we must say, that our experience of construction of high speed boats has been decidedly enriched by Mr. Parsons' bold experiment. It is to be regretted, however, that the success has not been attributed to the real causes, but rather used for an one-sided advertisement of a special type of engine. The expression that, "the total weight of machinery in torpedo boats on the turbine system will probably not exceed one-third that of ordinary engines of the same power," is decidedly incorrect and only misleading.

THEODORE LUCAS.
Philadelphia.

Shipbuilding in Bath, Maine.

In no shipbuilding center is there more activity at the present time than Bath, Me. A list of vessels now contracted for by the local shipbuilders includes:

Bath Iron Works, two 30 ½ knot torpedo boats, $390,000; one lightship, composite, $75,000; one steel cargo steamship, $190,000; one steam yacht, $450,000; Gardiner Deering, one four masted schooner, $68,000; Arthur Sewell & Co., steel sailing ship, $185,000; N. T. Palmer, one five masted schooner, wood, $80,000; Percy & Small, one four masted schooner, wood $65,000; Kelley, Spear & Co., one ferryboat, wood, $30,000; nine coal barges, wood, $210,000; New England Shipbuilding Co., one wood passenger boat, $20,000; one four masted schooner, $60,000; three wood barges, $70,000; grand total is $1,893 000.

It is expected that the Bath Iron Works will be awarded the contract for the composite practice vessel for the Naval Academy. This will add about $175,000 to the above total and it is rumored that other contracts will be closed in a few days. The three barges building by the New England Shipbuilding Co. are 200 ft. long, 35 ft. beam, 17 ft. deep, with a carrying capacity of about 1,600 tons each. Three of the barges building at the Kelley & Spear yard are for the Staples Coal Co., of Taunton, Mass., and two are for the Black, Sheridan, Wilson Co., of Baltimore. Two of the former have a capacity of 1,500 tons each and are 180 ft. long, 36 ft. beam and 16 ft. deep. The remaining barge for the Staples Coal Co. will have a capacity of 500 tons and will be 133 ft. long, 31 ft. beam and 8 ft. deep. The two barges for the Baltimore Co. have the same dimensions as the New England Co.'s boats. The passenger boat building by the New England Co. will serve as a tender to the Wentworth House, Portsmouth, N. H. She is being built to the order of Frank Jones and is designed by the Bath Iron Works, which concern will build the machinery. She is 93 ft. long over all, 85 ft. water line, 18 ft. 6 in. beam on water, 22 ft. 6 in. extreme beam and 6 ft. draught. She will be fitted with a water-tube boiler. N. T. Palmer's schooner will be the largest schooner in the world and much larger than the Gov. Ames, and the other vessels of the Palmer fleet. The steel ship which is being constructed by Messrs. Arthur Sewell & Co. is very similar to the Dirigo, which was built by this firm three years ago. She is 312 ft. long on the water line, 45 ft. beam, and is designed to carry 4,400 tons dead weight on 22 ft. 6 in. draught, and to stand up without ballast when light in port. The ferryboat building by Kelley, Spear & Co. is for the Maine Central R. R. to replace the old City of Rockland, and to act as a spare boat on the Kennebec river between Bath and Woolich. She is a side wheeler about 130 ft. long. The Bath Iron Works is to build the machinery.

EDUCATIONAL.

THE ART OF MAKING MECHANICAL SKETCHES, FOR MARINE ENGINEERS.—III.

BY PROF. C. W. MACCORD.

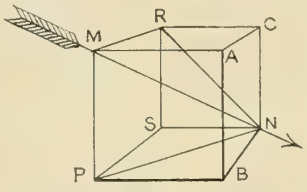


FIG. 10.

When two elevations and a plan are required for the complete representation of an object, these three views are ordinarily disposed in relation to each other as explained in the preceding article in connection with Fig. 5.

But sometimes space can be saved, without at all impairing the clearness of the drawing, by adopting a different arrangement, which is illustrated in Fig. 8. We have here a small bed-plate, or stand, such as might be used for supporting a mechanical model; it consists of a flat plate, stiffened all round by a flange on the lower side, which at each corner is extended downward, thus forming four L-shaped legs; on the top are four small facing-strips with lugs. Sup-

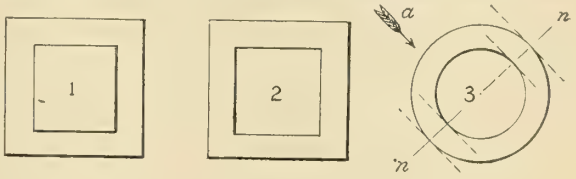


FIG. 9.

pose this bed-plate to be cut lengthwise by a plane *n n*, and the nearer portion to be removed; then the front view A represents the part that is left, thus forming a *sectional elevation*, the divided metal being indicated by hatching, or as it is oftener called, "sectioning," it with fine parallel lines inclined to the outlines. Simple as this subject is, it is apparent that the structure is thus shown much more clearly than it would be by an outside view.

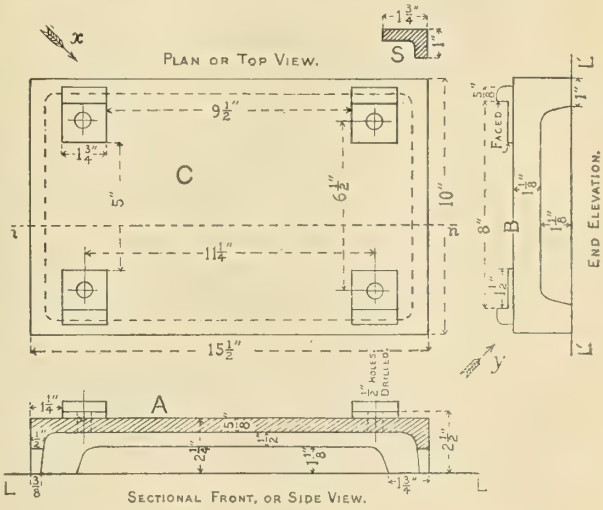


FIG. 8.

Above this is placed the top view C; and so far the arrangement is the same as in Fig. 5. But the end elevation B, instead of being placed at the right of A, is placed at the right of C; by turning the drawing so as to make the base line L' L' horizontal, it will be seen that *C* will have the same relation to B that

it now has to A, and can be studied in connection with it, perhaps even more advantageously than it could be if it had been placed as in Fig. 5. And since the height of the object is small is comparison with its breadth, the whole drawing is made much more compact than it would have been, by this simple expedient, which may also be employed with excellent effect in other cases: thus, for example, had it been required to make a transverse section as well as an end view, then instead of stringing these out side by side, one might be placed at the right of A as in Fig. 5, and the other at the right of C, as here shown.

Another "wrinkle" is illustrated in Fig. 8, by introducing the section S, which is a top view of what would be seen were the L-shaped leg at that corner to be cut by a horizontal plane just above the base-line *L L*, and all above that plane removed. This obviates the necessity of showing this by dotted lines in the top view C, the attempt to do which, as a very little study will make evident, would have made the drawing rather confusing than explanatory, although it might be perfectly correct; it is often unwise to try to show in one view what can be better shown in two. And the addition to the principal views, of such auxiliary representations of certain parts, is frequently of great advantage in making original drawings, while to the one who is making sketches this expedient is invaluable.

Of Shadow Lines.

Lines may be distinguished as thin or thick, fine or coarse, light or heavy, indifferently. It will have been noticed that in this respect the outlines of several of the preceding figures differ among themselves to a marked degree, and no one can have failed to be struck by the effect of *relief* thus produced. Particular attention to this is called in Fig. 9; comparing *1* with *2*, it is perfectly obvious that the former represents one square block lying above another, while the latter represents a similar block with a square hole through it, or at least with a square depression in it; and in like manner, 3 represents a circular disk with a round hole through it. The outlines, then, are not mere diagrams, but represent objects having sensible thickness, which if resting upon a plane surface would cast shadows upon it. The lines which are made heavy in all cases represent the sharp *edges* of surfaces which intercept the light. Thus they not only produce relief, but enable us to distinguish an object which has sharp edges, as a prism or a pyramid, from one which has not, such as cylinder or a cone. It would be impossible here to explain how to determine in all cases what visible lines do cast shadows; but the intelligent reader may be guided to some extent by the consideration that much depends upon the direction in which the light comes. For the sake of uniformity it has been agreed that this shall be as shown in Fig. 10. There the large arrow represents a ray of light, which pierces the transparent cube at the upper left-hand corner *M*, and passing bodily through it, emerges at the lower right-hand corner *N*. From what precedes it will be clear that the projection of this ray on the vertical face *S C* will be *R N*, and the projection on the horizontal face *S B* will be *P N;* since each face is a square both *R N* and *P N* make angles of 45° with *S N*, which is a horizontal line. In this figure then it is apparent that of the three visible faces of the cube, the upper face *M C* and the front face *A P* will be illuminated, while the right-hand face *B C* is not; so that the edges *P B*, *B A*, *A C*, intercepting the light, would cast shadows, and these lines are accordingly made heavier than the other outlines.

Now in Fig. 9, the direction of the light being indicated by the arrow *a*, the lines which cast shadows in the two objects at the left can be determined by mere inspection. As to the one on the right, it is equally obvious that the shadows will be cast by the lower right-hand part of the outer circle, and by the upper left-hand part of the inner one; and the points where these shadows begin and end will be the points of contact of lines parallel to *a* and tangent to the circles; they may be exactly located by drawing *n n* through the center and perpendicular to *a*. At these points the thickness of the shadow line will be no greater than that of the outlines, and will gradually increase, being greatest at a point midway between them.

In the case of any *elevation*, then, the shadows fall toward the lower right-hand corner; but in a plain

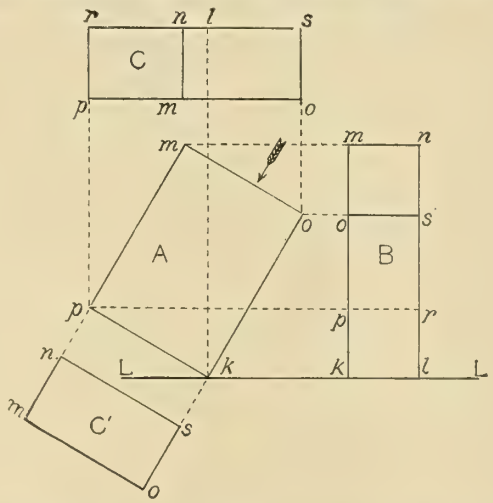


FIG. 11.

view, they would fall toward the upper right-hand corner, were the direction of the light shown in Fig. 10 to be adhered to. But since in studying a plan the observer is supposed to be looking downward, the light if coming from above must come from behind, the actual direction is of less consequence, and therefore may be assumed to pass through the cube in the direction *R B*. This has the effect of causing the shadows to fall toward the lower right-hand corner,

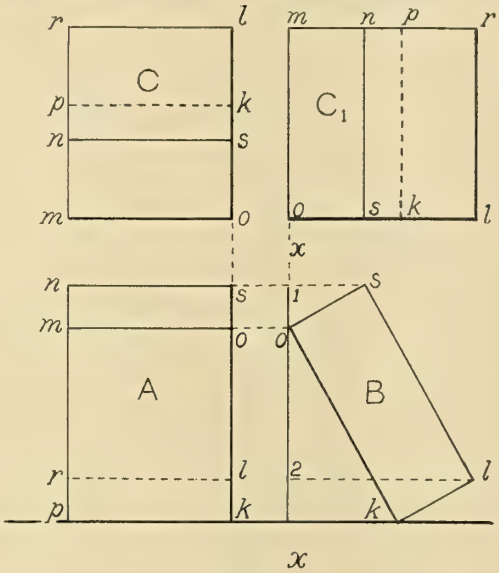


FIG. 12.

and for the sake of uniformity this is, in this country and in England, the accepted practice. This is illustrated in Fig. 8, where the arrow *x* indicates the direction of the light for the plan as well as for the sectional front view A, and would serve also for the elevation B had it been placed at the right of A as in Fig. 5. But since in studying this view the base line

L′ L′ must be horizontal, the light must come in the direction shown by the arrow *y*. Also, it is to be noted that the figures and the writing in this view are so arranged that in order to read them with facility, the drawing must be turned so as to bring the base line into a horizontal position.

Logically, this discussion may seem rather premature, but in spite of the fact that a line which intercepts the light is in reality no thicker than one which does not, it is beyond dispute that the use of shadow lines not only improves a drawing by producing the

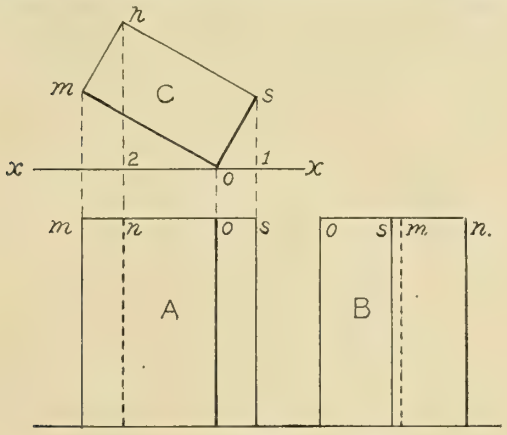


FIG. 13.

effect of relief and solidity, but for that very reason it facilitates the *reading* of the drawing and makes it more intelligible. And these lines are just as effective in the rudest sketch as in the most elaborate drawing: some idea of their meaning and of their proper location should therefore be acquired at an early stage.

Representation of Objects in Oblique Positions.

As the first step in this direction, the same simple block shown in Fig. 5 is reproduced in Fig. 11; not

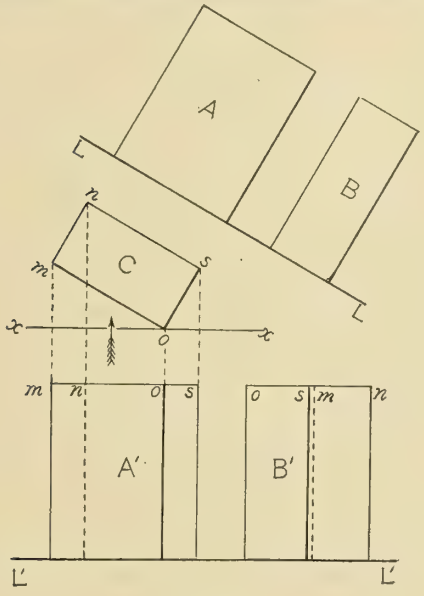


FIG. 14.

in the vertical position, but inclined to the right in the front view A, having been turned upon its right-hand lower edge, represented by *k*, as upon a hinge. The points *k*, *p*, etc., here represent, just as they did in the original position, right lines perpendicular to the paper, and of a length equal to the thickness of the block. Therefore in the view B they will be seen in their true length as the horizontal lines *m n*, *o s*, etc., their heights, or distances above L L, being the same as those of their extremities *m*, *o*, etc., in the front view. And in the top view they will also appear in their true length, each being perpendicularly above its corresponding representation in the view A. By this rotation, then, the front view is not changed, either in form or in dimensions; and the distances from front to rear, as seen in the views B and C, are likewise unaffected. The heights of various points are changed, but they are still alike in A and B; the distances from right to left in A and C are changed, but they are yet the same in both those views.

There is shown in this figure an additional view C′, which represents the upper face of the prism, as it would be seen by looking in the direction of the arrow; which appears therefore in its true size and form. This arrangement is often of great utility both in drawings and in sketches.

Next, in Fig. 12 the same object is represented as tilted over toward the observer, turning about the edge *p k*, which in the view B appears as the point *k*. Neither the form nor the dimensions of this view are changed, nor are the *breadths* in the other two views affected by this rotation. The front view therefore shows the lines *n s*, *m o*, etc., of their true length, and at heights the same as those of *s*, *o*, etc., in the view B. If the top view C be placed as heretofore, over the front view, these lines will also be seen in their true length, and their distances from each other are obtained from view B, thus: Draw a vertical plane *x x* through the corner *o;* this contains the nearer edge *m o*, and in C the distances *o s*, *o l*, etc., are equal to *1 s*, *2 l*, etc., being the distance of *s*, *l*, etc., from *x x*. But the top view may be placed over the side view, as shown in C_1; in which case the lines *o m*, *s n*, are simply projected up from *o s*, etc., in the view B, their lengths being made the same as in view A. Of these two positions of the top view, either may be used at pleasure or according to con-

Third, placing the prism upright again, in Fig. 13, let it be turned around one of its vertical edges. The top view C is then unchanged in form and dimensions, and evidently the height remains unaffected. The positions of the vertical edges in view A will clearly be directly under the points *o*, *s*, etc., in the top view. Drawing a vertical plane *x x* through the nearer edge *o*, parallel to the paper in the front view, the side view B is constructed by making the distances *o s*, *o n*, etc., equal to *1 s*, *2 n*, etc., in view C, being the reverse of the process before described in connection with Fig. 12.

The same result may be reached in another way, which is frequently of great convenience, and is illustrated in Fig. 14. Here A. B., and C represent the prism in its original position. The top view is placed below instead of above the front view, which again is purely optional, one position being as correct as the other. To use a geographical illustration, A is a view of C as seen from the south, and B a view as seen from the east. Now without changing the position of C, let us make a view of it as seen from the southeast—or nearly so—as shown by the arrow. The horizontal plane will then appear as L′ L′, perpendicular to the arrow, and the new front view A′ is constructed by projecting *m*, *o*, etc., perpendicularly upon this new base line. The plane *x x* is drawn through *o*, as before, and the new side view B′ is constructed by means of it precisely as B was in Fig. 13.

It has already been remarked, that in making either a sketch or a finished drawing, the simplest position in which the object can be placed is always the best. But the structure may be of such a nature that when the simplest postion for the whole has been selected, some parts of it may be inclined, and necessarily must be *foreshortened* in the representation. Some knowledge of the methods of dealing with such cases is, therefore, essential, and is preferably to be acquired as soon as possible.

ENGINEERS' DICTIONARY.—II.

Air Gauge or *Draft Gauge.*—An instrument for measuring the excess of air pressure in the ash-pits or fire-room over atmospheric pressure, or for measuring the defect of pressure in the uptake or smoke-stack base relative to the same standard. The simplest form consists of a bent tube containing water in the lower part. One of the open ends is connected with the space within which the pressure is desired, and the other is left open to the air. If a difference of pressure exists, the two legs will not stand at the same height. One will rise and the other fall, the movement being toward the lesser pressure. The difference in height will then represent the difference in pressure, and is usually read in inches. It is for this reason that draft pressures are usually expressel in inches of water. With ordinary stack draft the pressure is usually from 1-4 in. to 1-2 in., or 3-4 in., with assisted mechanical draft from 1-2 in. to 1 in., with forced draft on large ships from 1 in. to 2 in., while on torpedo boats and fast yachts the pressure may rise to 5 in., or 6 in., or more.

Alarm Valve or *Sentinel Valve.*—A valve placed on a boiler for the purpose of indicating the existence of low water. There are many varieties of such devices. In some the fall of the water below a certain point uncovers the open end of a pipe, allowing the water with which it was previously filled to flow out. This pipe extends upward outside the boiler, and is closed at the outer end with a plug of fusible metal, beyond which may be placed a small steam whistle, if desired. So long as this pipe is filled with water, its temperature at the plug will be lower than the melting point of the latter, but on the entrance of steam the plug melts and the escaping jet furnishes the warning desired. In other cases the fall of the water carries with it a float, connected by lever arms and rock shaft to some form of alarm placed outside the boiler.

Anti-Friction Metal or *White Metal.*—A general term for alloys specially intended for use on bearing surfaces. Such a metal should provide a surface which does not readily cut or abrade when the lubrication is scanty, and when properly lubricated the coefficient of friction should be very small. As a result the heat developed and elevation of temperature at high pressures per square inch of bearing surface will be small. The wear should be very slow and the durability consequently great, while at the same time the metal should not be so hard as to endanger transferring the wear to the piece which the bearing is to support, nor should it be too hard to work readily with a hand scraper. The well known *Babbitt metal* is one of the most familiar examples of this class of materials, though in recent years many other varieties have been placed on the market. Such metals are usually alloys of some two or more of the metals copper, tin, zinc, lead and antimony. The typical modern form of bearing consists of a backing or support of cast iron steel or brass to furnish the necessary strength and stiffness, lined on the bearing face with anti-friction metal cast into cavities with overhanging edges for holding it firmly in place.

Ash Chute or *Shoot.*—A shoot or cast metal tube, leading usually from a convenient point inboard to the outside of the ship, through which ashes are disposed of as hoisted from the fireroom. In modern practice the chute preferably leads down alongside the ship to a point below the water line, so that the ashes are ultimately discharged under water. A hose is often kept playing into the chute to assist in freeing the passage.

Ash Cock.—A cock admitting water from outside the ship, or in some cases from the delivery side of a pump, to a hose used for wetting down the ashes after their withdrawal from the ash pits.

Ash Ejector.—An apparatus for disposing of ashes directly from the fireroom. In Fig. 3 A represents a cast metal chute, or pipe, leading from the fireroom up and out through the side of the ship near or slightly above the water line. At the lower end this chute connects with a hopper B, into which is led a pipe from the discharge of a pump. This pipe enters to near the lower end of the chute, into which its discharge is directed, and is contracted to a nozzle, so that the water issues with a high velocity. The hopper may be closed by a cover, and if in this condition the discharge valve is opened and the pump started, a stream issues with high velocity from the upper end of the chute, even against the head of water which

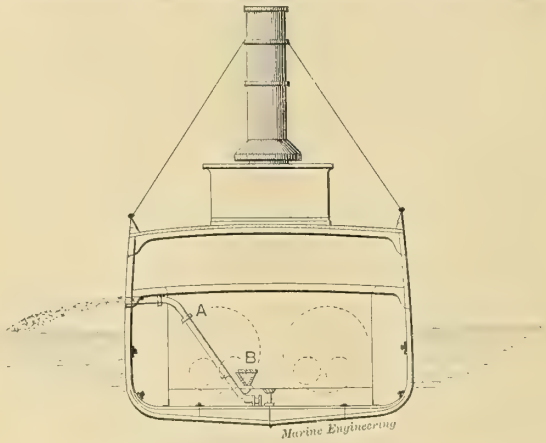


FIG. 3.

may result from the location of the latter below the water line. If then the cover is removed and ashes shoveled into the hopper, they are caught by the stream, carried rapidly up, and ejected free of the ships side in a jet of mingled ashes and water.

Ash-hoist.—A mechanism for hoisting ashes from the fireroom. The typical form consists of a small steam engine and winding drum, the engine being controlled by a simple form of reversing gear, so that it may be readily run in either direction or stopped.

Ash Pit.—The space within the furnace beneath the grate-bars. This space is used for the introduction of air beneath the grate, for working the fire from the under side, and for the withdrawal of the ashes.

Ash Pit Door or *Damper.*—A door covering the front of the ash pit and serving to check or control the inflow of air.

Atmospheric Line.—A line drawn on the indicator diagram, with the space below the indicator piston shut off from the steam cylinder and freely open to the air. This line often serves as a reference from which to measure pressures on the card above or below that of the atmosphere.

Auxiliaries.—A general term, including various machines and pieces of apparatus used in a more or less auxiliary or secondary manner. It is frequently used to include all machinery other than the main engines and attachments connected directly thereto. For example, auxiliary boiler, auxiliary pump, auxiliary valve, etc.

Babbitt Metal.—See *Anti-friction metal.*

Baffle Plate.—A plate or sheet of metal placed in a current of gas, liquid or vapor, for the purpose of controlling or directing its motion. Thus baffle plates are placed in the furnaces, or among the tubes of certain boilers for the purpose of directing the flow of hot gas through or among the tubes; they are also placed in the water space of other boilers to assist the circulation, while in a condenser they are used to intercept the rush of steam directly toward the air pump suction, and to compel it to pass into other parts of the condenser, thus giving a more uniform distribution over the cooling surface.

DURING THE MONTH.

Belfast, Ireland, imported American pig iron direct.

The British torpedo boat Empress, launched at Laird's yard in Birkenhead, is designed for a speed of 33 knots. She is 235 ft. long and has engines of 10,000 I. H. P.

A record in the discharging of a coal cargo was made by the steamer Chili at South Chicago. With four rigs 3,179 tons of coal were unloaded in 16 hours and 45 minutes.

H. M. battleship Magnificent made a new British record for coaling at sea. She took on 775 tons at the average rate of 160 tons an hour. The highest hourly record was 174 tons.

Cable advices reported placing of an order by the Hamburg-American line for a sister ship of the monster "Pennsylvania," which was described and illustrated in our issue of April last.

The largest floating dry dock in this port was put in the water at Erie Basin, Brooklyn. It is 270 ft. long and has a lifting capacity of 2,500 tons. It was built by the owners, William Gokey & Sons.

The Craig Shipbuilding Co., of Toledo, secured the contract for the steel inspection vessel for the use of the U. S. Engineer Corps at Buffalo. Contract price was $11,970 and delivery was guaranteed before April 15, 1898.

Plans for the new Allan line steamship Castilian, to ply between Liverpool and Montreal, have been approved. She will be 520 ft. long, about 58 ft. beam and of about 9,000 tons. She will be of the intermediate type, with large freight and good passenger accommodation and of moderate speed.

The large machine shop of the American Steel Barge Co.'s new plant at Superior was completed and preparations begun for installing the heavy machinery. A variety of other improvements are well under way, including an air compressing plant for working pneumatic tools and riveters, and electric hoists and traveling cranes.

A big auxiliary yacht, the Princess Alice, for the Prince of Monaco, was launched at Laird's yard in Birkenhead, England. She is 225 ft. long, 34 ft. beam and 20 ft. deep, and is designed to steam at 12 knots. The Prince is known in the scientific world as an enthusiastic biologist, and will use the yacht while cruising to take deep sea soundings.

The committee of Lloyd's which had under consideration the North Atlantic load-line question recommended the application of the winter load-line to all points north of Cape Hatteras. This would do away with the advantage which is now enjoyed by several southern ports in the loading of vessels deeper than is allowed from northern ports.

Arrangements were about completed between the New York, Philadelphia and Norfolk Railroad Co. and the Delaware River Iron Ship and Engine Building Co. for the construction of a new passenger vessel for the Cape Charles route. She is to be a single screw boat, 230 ft. long, 41 ft. beam and 15 ft. deep, to carry 250 passengers and a large amount of baggage.

The fireboat W. L. Strong, launched recently at the yard of John A. Dialogue & Son, Camden, N. J., is being rapidly completed for service in New York harbor. Her general dimensions are: Length, 110 ft.; beam, 20 ft.; draught, 9 ft. She is fitted with a single screw driven by a compound engine, and with pumps with a capacity of 6,000 gallons per minute, delivered at a pressure of 175 lbs. per sq. in.

An order is soon to be made in the British Navy granting warrant rank to the "Engine Room Artificers" who are employed in large numbers in the fleets as assistants to the commissioned engineers. Fifty appointments will be made and this number gradually increased. A rather stiff examination will have to be passed to get this promotion, and only those who have had ten years' continuous service will be eligible.

The steamer Spartan Prince, built by Short Brothers, Sunderland, England, for the Prince line, to ply between New York and Genoa, was sent on her trial trip. She is about 5,000 tons, dead weight, and is fitted with triple-expansion engines of 2,600 I. H. P. A mean speed of 15 knots was reached. This vessel, besides having large freight capacity, has accommodation for fifty first-class passengers and about 1,000 in the steerage.

A contract was concluded by the Detroit Dry Dock Co. for the construction of a steel propeller for a Puget Sound syndicate for service on the Pacific coast. The dimensions are, length, 165 ft.; beam, 27 ft.; depth of hold, 13 ft. Triple-expansion engines of 1,000 horse power will be fitted with boilers equipped with Howden hot draught. She is intended to carry a large number of passengers and about 250 tons of freight. The cost is given as $75,000.

A new record was made by the steamship China of the Pacific Mail line between Yokohama and Honolulu and between Honolulu and San Francisco. The entire trip, including 19 hours and 36 minutes detention at Honolulu was 14 days, 12 hours and 18 minutes. The passage from the Islands to 'Frisco was made in 5 days, 7 hours and 41 minutes. The highest speed attained on the trip was 18.85 knots. The previous records of the vessel were beaten by 1 day, 1 hour and 40 minutes.

The annual report of the Pacific Mail Steamship Co. for 1897 shows that the number of passengers carried to and from China and Japan was about 12,000, an increase of 25 per cent over the previous year, and about 40 per cent more than the number for the corresponding trips in 1895. Of these figures a considerable percentage is composed of tourist travel. The company has been figuring for some time upon the construction of a new vessel, which will probably be in the neighborhood of 7,000 tons.

A deal was perfected by which the stockholders of the Globe Iron Works Co. secured control of the Ship Owners' Dry Dock Co., which now gives them a controlling interest of all the dry dock property in Cleveland, as they already control the Cleveland Dry Dock Co. The docks acquired by the Globe Co. are in dimensions, respectively: 430 ft. long, 50 ft. wide and 16 ft. over the sill, and 300 ft. long, 55 ft. wide and 13 ft. over the sill. With such extensive dock accommodation the company is in position now to repair the hulls of several vessels simultaneously.

The steamship Persia, of the Hamburg-American line, was purchased by the Atlantic Transport line to run between New York and London. She was built by Harland & Wolff in 1894, and is 445 ft. long with a net tonnage of 3,687 tons. Other changes of vessel ownership include the transfer of the Red D line steamer Curacoa to a syndicate for use in the Alaskan trade, and the Morgan line steamship Morgan City to the Joseph Ladue Mining and Developing Co., for the same trade. The sale of the Cunarders Scythia and Parthia for service between Seattle and St. Michael was also reported.

The New York and Cuba Mail Steamship Co. closed a contract with the Cramps, of Philadelphia, for two 5,000 ton, 16 knot twin screw steamers. They are to be built in accordance with the requirements of the Government for auxiliary cruisers, so that in time of war they can be equipped with quick-fire guns. The general dimensions are given as, length, 360 ft.; beam, 50 ft.; depth, 32 ft., and draught about 20 ft. Triple expansion engines and Scotch boilers equipped with Howden draught will be installed. The vessels will have two smoke stacks and pole masts. Passenger accommodation will be unusually fine.

QUERIES AND ANSWERS.

Q.—Is it true that the beam of a side wheel engine stops moving during each revolution? R. C.

A.—Yes. When the crank is passing over the center the beam is at rest, or in other words, it is motionless twice during each revolution.

Q.—The engineer on our boat says you cannot see steam. Is he right? F.

A.—Look in the gauge glass between the water and the top of the glass, when steam is up, and judge for yourself. If you don't believe the steam is there try smashing the glass with a shovel or any thing handy, and you will get a practical demonstration that you will likely remember.

Q.—What is meant by the terms "lead" and "throw of the eccentric" used with regard to an engine?

FIREMAN.

A.—Lead is the amount of opening given to the valve on the steam side when the engine is on the center. The throw of the eccentric is the distance between the center of the crank shaft and the center of the eccentric. An eccentric is simply a substitute for a crank, to convert a rotary into a reciprocating, or to and fro motion, and so you can readily see the applicability of the term you mention.

Q.—What is the smallest amount of coal needed to produce one horse power per hour? T. S.

A.—The best record made by a land engine was 11 67 pounds of steam per horse power. Tests have shown more than twelve pounds of steam produced with one pound of coal. With a combination of multiple expansion engines and boilers equipped with hot draft and very modern feed water heating appliances in the S. S. Inchmona, a record of .999 pounds of coal is claimed. This is probably the figure for main engines only. It is the auxiliaries in a vessel which are really wasteful of steam, and the coal consumption as usually stated, includes all steam apparatus from the main engines to the steering gear.

Q.—Please state a rule for finding the velocity of flow of water in a pipe? N. P.

A.—The following formula is what is required:

$$V = 48\sqrt{\frac{h}{l}\,d}$$

In this V = the velocity of flow in feet per second, h = the head of water in feet, l = the length in feet, and d = diameter in feet. The rule is: Divide the head in feet by the length in feet, multiply the product by the diameter in feet, extract the square root of the product, and multiply by 48. The product will be the velocity in feet per secoud.

Q.—I had an argument with a man who insisted that if the valves of the water gauge are partially closed the pressure in the glass will be less than that in the boiler, or than would be in the glass if the valves were wide open. Is tnis so? T.

A.—No, it is not. No matter how small the opening through the valves might be the pressure in the glass, and consequently the water level, would be exactly the same as in the boiler, though, of course, a glass with wide open connections would more quickly show changes of water level than one with the openings partially closed. Carelessness in packing a gauge glass will sometimes choke the opening and reduce the area of connection with the boiler considerably, and this might be so for a long time and not noticed. It should be the aim of an engineer to keep gauge connections clear and full open at all times when under steam.

Q.—We have a jet condenser made of cast iron, the same kind as that used with beam engines on boats. It is honey-combed or eaten away at the manhole. Which is preferable for a patching, brass or copper? If the brass is preferable kindly state what objection there is to copper or vice versa?

ONE OF YOUR READERS.

A.—If the corrosion you mention is due to electro-chemical action, or to galvanic action, as it is frequently called, and if salt water is used in the condenser, brass or bronze would be preferable to copper for the material of the patch. This is due to the fact that the electro-chemical action between iron and brass is much less strong than between iron and copper. In your case, however, we assume that fresh water only is used in the condenser, and if so, there would be little choice between the brass and the copper, so far as corrosion due to electro-chemical action is concerned. This is because all such actions in fresh water are very weak. So far as resistance to corrosion from chemical causes alone is concerned, copper is usually somewhat more resistant than brass, and might in this case be preferable. We would suggest, however, that in case the nature of the repairs is such as to allow the fitting of a patch or cover of iron or steel, this would probably be more satisfactory than either brass or copper so far as corrosion is concerned, whether due to chemical cause alone or to electro-chemical action.

OBITUARY.

The death of the eminent hydraulic engineer, James Platt, on December 29, is announced by our English exchanges. Deceased was head of the firm of Fielding & Platt, hydraulic machine tool builders, of Gloucester. Besides having the management of an extensive engineering business, deceased was very prominent in scientific circles in England. He was a member of Council of the Institution of Mechanical Engineers, a member of the Institution of Civil Engineers and also of the Iron and Steel Institute. He was a native of Manchester, where he was born in the year 1834. He received his technical education as an articled pupil in the great machine tool shops of Francis Berry & Sons, Sowerby Bridge, Yorkshire, where his father was works manager. Afterward Mr. Platt was engaged in general engineering work, taking special interest in smelting apparatus. It was in 1866 that the firm of Fielding & Platt was founded. In conjunction with R. H. Tweddell, Mr. Platt secured the first patents for a hydraulic riveting machine in 1873. Since then the firm has built a large proportion of the hydraulic shop machinery in use in Europe. One of the last big jobs undertaken by the firm was the special riveting plant for the construction of the White Star leviathan Oceanic, now building at the yard of Harland & Wolff, at Belfast. Deceased is survived by a widow, five sons and a daughter. His eldest son, John Platt, M.E., is now engaged in engineering work in New York.

Jacob G. Neafie, president of the Neafie & Levy Ship and Engine Building Co., died at his residence, 1201 North Broad street, Philadelphia, January 16. He was 82 years old, but, nevertheless, up to a day or two before his death he gave personal attention to professional work at the office of the company. Deceased was the founder of the business, which from 1860 to 1891 was a private enterprise, but in the latter year became an incorporated company. He was born on Christmas day, 1815, in Monmouth county, N. J., and while he was quite young the family moved to New York city, where he was educated. In his earlier years he showed a marked ability for mechanical invention, and after a good practical training he opened a machine shop in Philadelphia. In the year 1844 he moved to the premises now occupied by the company at Beach street, and took in two partners. The versatility of his genius was shown in the construction of a successful steam fire engine for the city of Philadelphia, which is still in active service. His attention to this form of engine had been called in a casual way. Many fine vessels have been launched at the company's yard during his long administration.

Hiram G. Southworth, an old-time shipbuilder, died at his home, 27 Park street, Medford, December 20, aged 94. He was born at Duxbury, March 4, 1803. After learning the trade of ship joiner he came to Medford early in 1831, and with the exception of one year, when he was employed at the yard of Jenks & Coffin, Salem, his whole after life was given to the building of the stanch merchant vessels that gave shipbuilding on the banks of the Mystic a widespread reputation. He was probably the oldest Free Mason in the country, having been a member of the fraternity for 71 years.

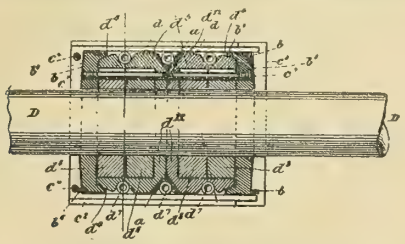
John J. Crofts, a pioneer marine engineer on the Pacific coast, died late in December, about 66 years of age. He was born in Lynn Crofts, Nottinghamshire, England, and went to the Coast in 1849. He was in the service of the Pacific Mail Steamship Co. for twenty-seven years and was then transferred to the Pacific Coast Steamship Co., and there remained until the time of his death.

Owen Williams, a well known lake marine engineer, of Detroit, died of pneumonia at Chicago, aged 70 years. He was an active member of the Marine Engineers' Beneficial Association.

SELECTED PATENTS.

595,811. METALLIC RING PACKING. *Leopold Katzenstein, New York, N. Y. Filed March 3, 1897.*

In a packing, the combination of sectional end rings *b*, intermediate sectional rings *d* recessed for the reception of sectional metal pieces d^8, the rings *d* being beveled at each end and recessed peripherally, springs for holding the rings *d* firmly around the piston-rod, a triangular spring expansion-ring *a* intervening be-

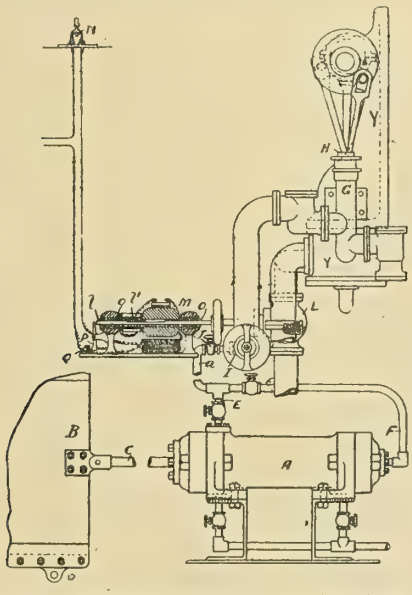


KATZENSTEIN METALLIC PACKING.

tween the rings *d d* and a pin or pins for holding the rings in alignment, adjacent sectional rings breaking joints with each other from end to end of the packing. The combination of inside conical flanged end rings *b*, intermediate sectional rings *d* recessed for the reception of segmental pieces d^8, the said rings *d* being beveled at one end to enter the flanged end rings *b* and at the other end to form a triangular groove, a triangular spring expansion-ring *a* between the rings *d*, means for preventing the rings from turning one on the other, the said rings breaking joints with each other from end to end of the packing. The combination of flanged end rings, intermediate sectional spring-rings beveled at one end to enter the flanged end rings and at the other end to form a V-shaped groove, the intermediate rings being recessed for the reception of segmental pieces d^9 and provided with flanges d^{12} and a sectional spring-ring *a* intervening between the intermediate rings.

592,430. APPARATUS FOR CLOSING WATER-TIGHT BULKHEAD-DOORS. *Thomas Moodie, Hamilton, Scotland. Filed November 7, 1897. Patented in England, July 7, 1896.*

Apparatus for closing bulkhead-doors in steamships

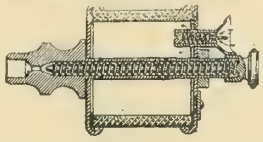


APPARATUS FOR CLOSING BULKHEAD DOORS.

consisting of a steam-pump whose steam-supply valve is connected to and actuated by an electromotor brought into operation by a switch on the bridge or other part of the ship and a hydraulic or other pressure cylinder connected to each bulkhead-door and whose plunger is actuated by fluid under pressure supplied by the pump. In apparatus for closing bulkhead-doors in steamships the combination of a hydraulic or like pressure cylinder having its piston-rod or plunger connected to the bulkhead-door, a ram or pump operated by a steam-engine to supply fluid under pressure to the hydraulic cylinder, an electromotor having its armature-spindle arranged to operate the steam-supply valve of the engine and conductors provided with switches on the bridge and at other suitable points for bringing the electromotor into operation. In apparatus for closing bulkhead-doors in steamships, the combination with a steam-pump adapted to transmit power for actuating the door, of an electromotor having its armature-spindle connected to the steam-supply valve of the engine and adapted by the action of the motor upon the throttle-valve to open it and admit steam to a high-speed engine provided with rams which supply fluid under pressure to the cylinders, the motor by its rotation opening a throttle-valve to admit steam to the engine.

592,179. OIL-CUP. *Wallace E. Tillinghast, East Greenwich, R. I. Filed Oct. 10, 1896.*

The combination with an oil cup for rapidly moving parts of machinery and provided with the cylinder, inlet and outlet openings for the oil, the stem, and upper and lower heads; of an air valve, provided with a casing inserted in an opening in the upper head extending partly within and partly without the cylinder and provided with lateral ports opening into the cylinder, a valve seat in the casing, a valve on the valve seat and arranged to open inwardly, and a spring in casing below the valve and normally holding the valve upon its seat, the valve casing being formed



OIL-CUP.

above the valve seat with an open flared or bell-shaped mouth into which the stem of the valve is extended, whereby the valve casing acts as a funnel and collects and concentrates the air directly upon the valve to unseat it when the cup is moving upwardly

CALENDARS FOR 1898.

The calendar sent to us by the Youngstown Iron & Steel Roofing Co., Youngstown, Ohio, has a handsome heading in a 12 in. half tone reproduction of the famous oil painting, "A Prisoner." It is an attractive calendar on green paper with gold ornamentation and printing in colors.

The calendar issued by the Central Electric Co., Chicago, is a very neat little desk calendar 4 in. by 5 in. in size, made to stand up. It has a sheet for each month on the front part and a complete calendar for the year on the back.

H. Bloomsburg & Co., Newport News, Va., and Wilmington, Del., issue a neat embossed calendar to which are attached several sheets with pictures of well known steamers using the jets and circulators manufactured by this company.

The most elaborate and one of the handsomest calendars issued this season comes from the E. G. Bernard Co., Troy, N. Y. In the center is a female figure holding aloft an electric torch, and about this figure are the months' calendars. On one side is a small thermometer. The workmanship is of fine handwork and is done in several colors.

Readers of Marine Engineering can have copies of these calendars by writing for them and mentioning this publication.

TRADE PUBLICATIONS.

A 3 1-2 in. by 6 in. 100-page book of endorsements from students in its mechanical courses is received from the International Correspondence Schools, Box 1111, Scranton, Pa. These endorsements are well worth the reading by men who contemplate a course in study, as they give an excellent idea of what these courses are and tell of results attained.

Boat, canoe and yacht hardware manufactured by M. E. Blasier & Co., Utica, N. Y., is fully illustrated and described in a 44-page catalogue just received. Each device is fully illustrated and there is almost everything in the line of brass and other metallic goods used in boat work. Every builder and user of small boats should have a copy of this catalogue handy for purposes of reference because of its completeness.

The demand for knock-down boats for Alaskan use has necessitated the issuing of a special circular by the American Knock-Down Boat Co., St. Louis, Mo. This circular contains descriptions of various types of boats, and has three large engravings showing the manner of constructing them, and also the compactness with which they are packed for transshipment. These boats are built for all services and include yachts and launches of any kind and size. To supply the Alaskan trade this company has opened an office at Seattle, Wash.

Machine tools for ship builders and metal workers of various kinds, manufactured by the Hilles & Jones Co., Wilmington, Del., are exceedingly well illustrated in catalogue O for 1898, just from the press. The catalogue is 9 in. by 12 in. in size, handsomely printed on coated paper, and each illustration occupies a full page, allowing barely enough space for brief descriptive matter. The illustrations are exceptionally good and show some massive tools which can be driven by belts or electric motors. Every ship and engine builder should have a copy of this catalogue.

BUSINESS NOTES.

A Good Dividend.—The directors of the Foster Engineering Co., Newark, N. J., at their meeting on January 18, declared a dividend of ten per cent. out of the earnings of 1897.

Change of Business.—The retirement is announced of Mr. Norman St. George Campbell from the firm of W. D. Forbes & Co., of Hoboken, N. J. Mr. Forbes, the mechanical expert of the firm, will continue at the head of the firm.

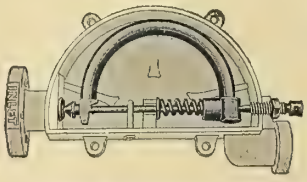
Burden Iron Chains.—In order that its chains and cables may be of the highest quality and abie to withstand the most severe strains, the J. B. Carr Co., Troy, N. Y., uses the celebrated Burden iron in all its chains and cables. A pamphlet giving a good deal of information regarding these chains is sent to all who wish it. It contains much information regarding weights, strength and sizes of cables, together with a number of testimonials from prominent users of chains in various parts of the country.

Yukon River Boat.—A very neat boat for use on the Yukon river, Alaska, has just been shipped by the Racine Yacht and Boat Works, Racine Junction, Wis. This boat was 35 ft. by 10 ft., very similar in type to the Gypsy Queen, illustrated in the January issue of Marine Engineering. Detailed description of this boat can be had by writing to this company. This company also has on hand a stern-wheel steamer for use on the Yukon river which is fitted with two 5 in. by 20 in. horizontal engines and Clyde marine boiler; a 25 ft. launch for A. Tubbs, Victoria, B. C.; one for C. B. Barber, New York city, one for William Tracy, South Ero, Vt., and still another launch for Cincinnati parties.

An Extra Engineer

not needed to look after the "Heintz" Steam Trap. It's automatic, sensitive, lasts for years. Operates by expansion of sealed tube, which closes the valve as live steam enters the trap — 212° : valve open at 211°. Smallest size discharges a gallon of water a minute.

Guaranteed to give best results and save coal and steam. Our Booklet "G" interesting to users. Ask for it.



William S. Haines Company,

136 South Fourth Street, Philadelphia.

"The Heintz—the best—tho' it has imitators."

21 COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y 12

LAMPS

For Every Purpose.

We make lamps for Yachts, Boats, Boathouses, Cabins, Wharves, Walks, or anywhere, indoors or out, where a good strong light is wanted.

Our goods need no recommendation from us. They are the standard. Other lamps are said to be "equal to," "like," or "as good as"

THE NEW ROCHESTER.

To be sure the lamps offered you possess the merits peculiar to the genuine, insist on seeing the name stamped in the metal. Catalogue free. We give as much attention to making special lamps, repairs, etc., as to our regular line.

THE ROCHESTER LAMP CO.

42 Park Place and 37 Barclay St., New York

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO.,
JERSEY CITY, N. J.

VALVES

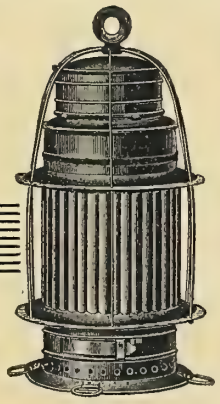
Of all kinds for automatically controlling Steam, Water and Air Pressures.

SEND US YOUR PROBLEMS.

Mason Regulator Co., Boston, Mass.

Light Rays in Signal Lamps should **be Concentrated** not diffused.....

These Lines Illustrate



the action of our patent
FLUTED LENS
on the rays of light in our
SIGNAL LAMPS.
Everything in Marine Lamps.
Shall we send you our catalogue?

Russell & Watson, 145 Main St., Buffalo, N. Y.

TRUSCOTT ENGINES.—The Truscott gasoline engine, illustrated in our January issue, was on exhibition at the Sportsmen's Show in New York last month, and was the first opportunity offered in the East to examine this new engine. Three different sizes were shown, of one, four and eight horse power. Because of the hurry in arranging for the display the company was not able to exhibit one of its boats, which have had a reputation for years for high quality. The Truscott Works are at St. Joseph Mich.

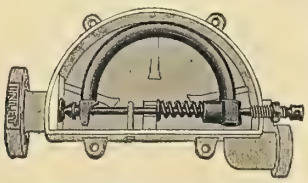
PLENTY OF WORK.—T. S. Marvel & Co., Newburg, N. Y., have all the work in their yard that they can possibly attend to for this winter. They are building a 60 ft. streel tug with a 14 by 18 engine for the Newburg Dredging Co., the steel hull for the new Catskill boat for which the W. & A. Fletcher Co., of Hoboken, will build the engines and boilers. Nine steamers are hauled out on the docks for extensive repairs and twenty-five are tied up alongside for repairs. One of these is the Ulster, which tried to "climb the mountain" as shown in our December issue. Strange to say, this accident, serious as it seemed, only cost $300 worth of damage.

ALCO LAUNCHES AND ENGINES.—The most conspicuous exhibit at the Sportsmen's Show in the boating line was made by the Marine Vapor Engine Co., Jersey City, N. J. There was a 25 ft. double cockpit yacht-tender fitted with a 5 horse power Alco engine. The launch was made of Spanish cedar, beautifully finished, and because of its unusual type attracted much attention. Adjoining this was a 25 ft. hunting launch equipped with a 3 horse power Alco engine, and as this launch had sail set, it was noticeable from all parts of the hall. In addition to this display the company showed two Alco engines which were operated by compressed air, the one horse power engine displaying a speed to the attached propeller which would make an electric fan motor envious.

23 Years

in constant use — and no failures. Thousands of dollars saved by the "Heintz" Steam Trap. Simple — Durable — Efficient. Works in any position — discharges water to any height. No floats, no levers or delicate parts. Economizes fuel and labor — saves space — perfectly automatic—requires no watching. Money refunded if trap proves unsatisfactory within a year. Send for one on thirty days' trial free.

Booklet "G" for the asking, will show you how to save money.



William S. Haines Company,
136 South Fourth Street,
Philadelphia.

"The Heintz—the best—tho' it has imitators."

©1 COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 11

THE EMPIRE MOTOR.—Three different sizes of the Empire gasoline motor were shown at the Sportsmen's Show last month, and circulars descriptive of them were distributed. This motor is manufactured by C. C. Riotte & Co., 1,955 Park avenue, New York.

MARINE RANGES.—A large number of steamers and barges on the lakes have been supplied with ranges and boilers by Russell & Watson, 145 Main street, Buffalo, N. Y., who carry a full line of these goods of their own production in addition to signal and other lamps, etc.

ANTI-FRICTION METAL.—The Eureka anti-friction metal advertised elsewhere by Fenton & Co., 39 Cortlandt street, New York, has made a reputation for itself as shown by very complimentary testimonials. It has proved especially efficient in marine work as the marine field is one to which the company has devoted itself. It makes in addition a line of non-corrosive metal goods.

DAIMLER MOTORS.—An excellent exhibit of the various uses to which Daimler motors have been applied was made by the Daimler Motor Co., Steinway, Long Island City, N. Y., at the Sportsmen's Show in New York city last month. It included both marine and stationary types of the engine, a very handsome launch, fully equipped, motor vehicles, etc. A neat catalogue descriptive of these applications of the motor was distributed.

GLOBE ENGINES.—The exhibit of Globe engines made by the Pennsylvania Iron Works Co., Philadelphia, Pa., at the Sportsmen's Show last month, comprised several engines, one of them being of 25 horse power. There was also a very handsome 33 ft. launch equipped with a Globe engine, with a large cabin forward and a cockpit aft of the engine room.

YACHT AND LAUNCH EXHIBIT.—The Gas Engine and Power Co., and Charles L. Seabury & Co., Con., Morris Heights, New York city, occupied a large space at the Sportsmen's Show in New York last month. The most noticeable exhibit was a superb mahogany launch 22 ft. long with large open cockpit. There was also exhibited a small Seabury boiler suitable for a small yacht, and two Seabury yacht or launch engines, one compound and the other triple expansion.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

POSITION WANTED.

An engineer of many years' practical experience in engineering and dredging, desires position, or would take charge of work for a contractor. Unexceptional references.

ENGINEER, care MARINE ENGINEERING.

Paul S. Reeves,

PHILADELPHIA,

Manufacturer of

Propeller Wheels

in all the BRONZES.

Marine Castings a Specialty.

Phosphor-Bronze, Brass, Babbitt Metals.

Castings from ¼ to 10,000 lbs. Weight.

Anti-Friction Metal.

Especially Adapted for

HEAVY AND HIGH SPEED ENGINE BEARINGS AND ALL KINDS OF MARINE WORK.

Outwears, runs cooler and with less lubrication than any babbitt or anti-friction metal made.

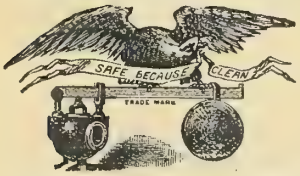
Descriptive Circular, Testimonials and Samples Free. . . . .

All Kinds of Superior Brass, Bronze, Copper and Non-corrosive White Metal Castings.

FENTON & CO., SELLING AGENTS,

39 Cortlandt St., New York.

THOS. C. WARLEY & CO., *Manufacturers of*



BOILER CLEANSING COMPOUNDS

Main Office: No. Eleven So. Ninth St., Philadelphia, Pa.

P. O. BOX 1262.

These Compounds are unequalled. They give satisfaction where others fail. They are especially adapted for use in Marine Steam Plants. WRITE FOR DESCRIPTIVE CIRCULAR.

COLE'S PRESERVER OF MARINE BOILERS

....For the Removal and Prevention of Scale and Corrosion....

It effectually prevents foaming, likewise galvanic action where the feed water is condensed and comes in contact with copper, brass or galvanized iron.

A. N. COLE, CHEMIST,

Foot of 24th Street, BROOKLYN, N. Y.

ES SE

n Havana

(*Supplement to M*

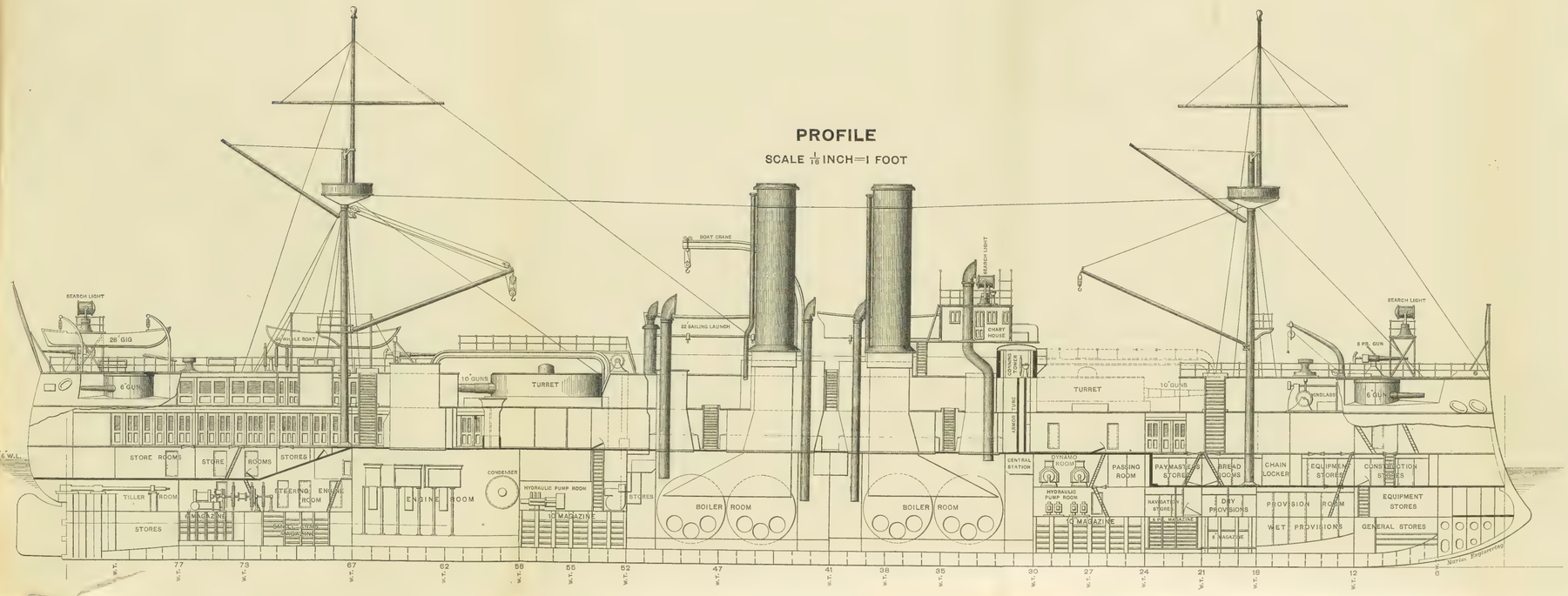
THE LATE UNITED STATES SECOND-CLASS BATTLESHIP MAINE.

Blown up and sunk in Havana harbor on the night of February 15, 1898.

(Supplement to Marine Engineering, March, 1898.)

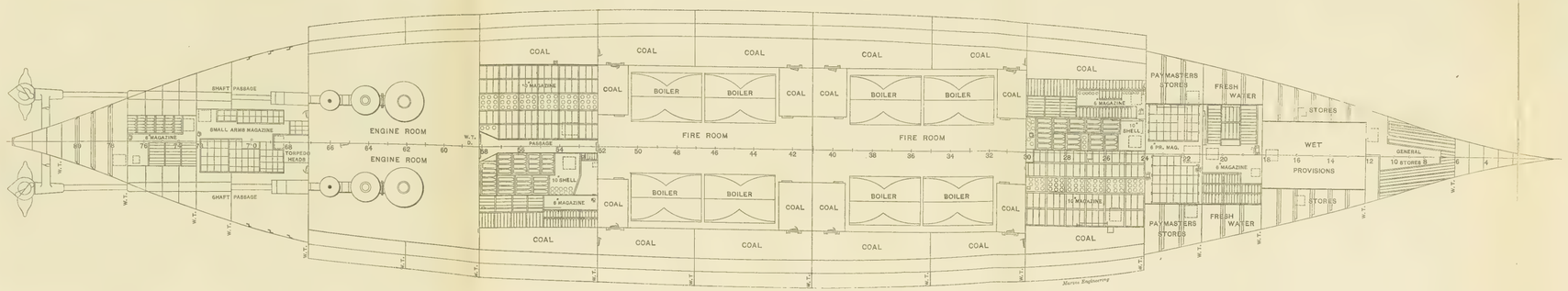
PROFILE

SCALE $\frac{1}{16}$ INCH=1 FOOT



HOLD PLAN

SCALE $\frac{1}{32}$ INCH = 1 FOOT.


SHAFT PASSAGE
SMALL ARMS MAGAZINE
6 MAGAZINE
TORPEDO HEADS
SHAFT PASSAGE
ENGINE ROOM
ENGINE ROOM
COAL
COAL
COAL
COAL
COAL
7 MAGAZINE
PASSAGE
10 SHELL
8 MAGAZINE
COAL
BOILER
BOILER
COAL
COAL
BOILER
BOILER
COAL
FIRE ROOM
FIRE ROOM
COAL
BOILER
BOILER
COAL
COAL
BOILER
BOILER
COAL
COAL
COAL
COAL
COAL

MAR 1 1898

MARINE ENGINEERING.

Vol. 2. NEW YORK, MARCH, 1898. No. 3.

DESTRUCTION OF THE U.S. BATTLESHIP MAINE BY AN EXPLOSION IN HAVANA HARBOR.

An explosion, from causes yet unknown, caused the destruction of the U. S. Second Class Battleship Maine in Havana Harbor, about 9.40 o'clock on the night of February 15. The ship was at anchor in the harbor, where she had been sent by the Government on a friendly mission. Darwin R. Merritt. Immediately following the explosion the vessel commenced to sink and Captain Sigsbee gave orders to abandon the ship. Boats from the Spanish war vessel Alfonso XII, which lay at a near anchorage, and from the steamer City of Washington, came to the rescue of those who had been in the forward part of the ship and who had been blown into the water. The Spanish authorities rendered all possible aid

THE LATE U. S. SECOND-CLASS BATTLESHIP MAINE, 5,500 TONS, 9,000 HORSE POWER.

The explosion, which was not preceded by any alarm, occurred in the forward part of the ship and for this reason the deplorable loss of life was most severe among the crew. Only two of the officers of the ship are missing, Lieutenant Friend W. Jenkins, and Assistant Engineer in caring for the survivors. Roll call showed that about 250 men and two officers were killed or missing. The Maine sank rapidly, coming to rest on the mud bottom in about six fathoms. In the accompanying illustration the appearance of the wreck next morning can be seen. The after

Copyright, 1898, by Marine Publishing Co., New York.

superstructure and portions of the midship superstructure littered with wreckage and one of the military masts showed above water. The Government at Washington at once appointed a board of inquiry, consisting of Captain W. T. Sampson, of the battleship Iowa; Captain French E. Chadwick, of the flagship New York; Lieutenant Commander W. P. Potter, of New York, and Lieutenant Commander Adolph Marix, Judge Advocate of the Court, to proceed to Havana and open a court of inquiry. Until this board has prepared a report it will not be possible to determine the cause of the explosion with any accuracy.

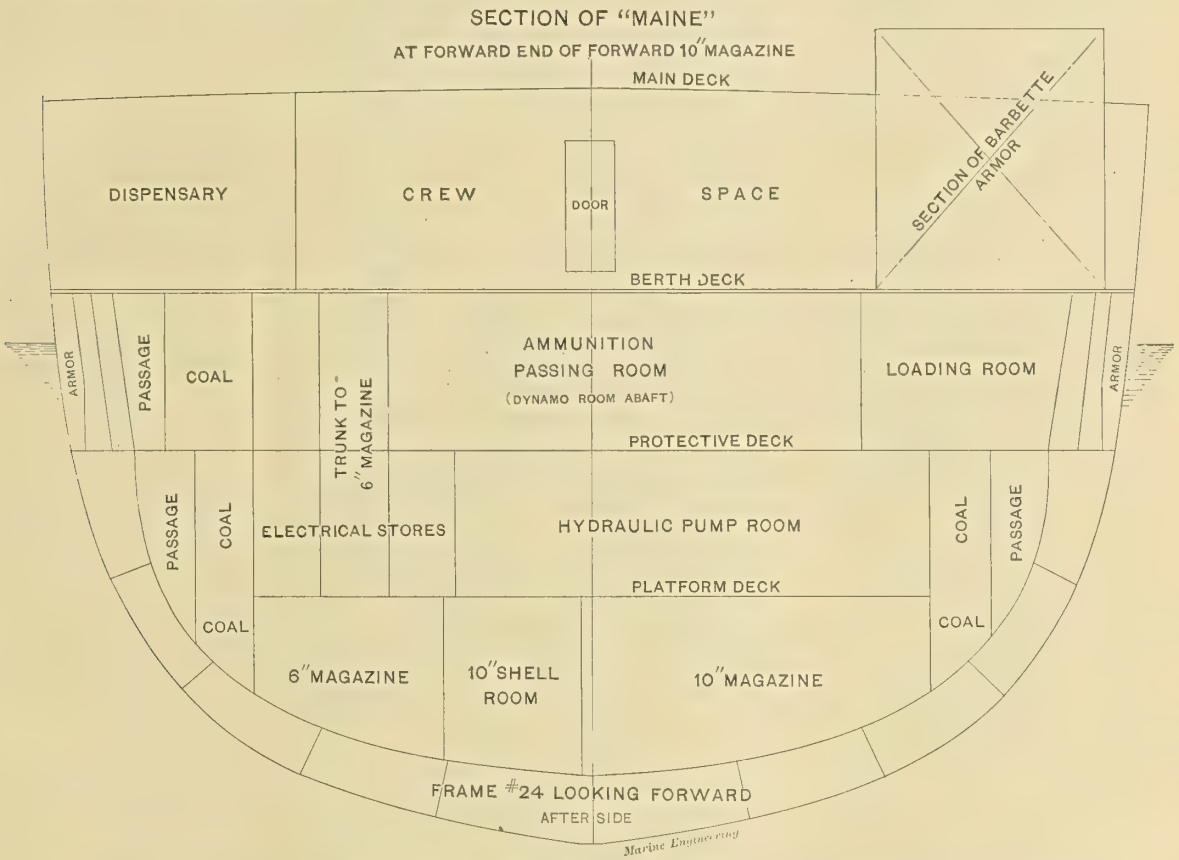
Immediately following the news of the disaster there was of course considerable speculation as to the probable cause, much of which found expression in the daily press. Wild and positive statements were freely made without a shadow of evidence in support, but the executive and legislative branches of the Government have maintained a wise and dignified reserve of official expression. It is only upon the lines of comparison between the effects of this explosion and those of other explosions, in naval experience, that any reasonable theory can be advanced. This, however, is likely to produce only empirical results, as the tendency is to make the facts agree with the theory. The work of divers who have been ordered to Havana to report to Capt. Sigsbee will, of course, narrow down the investigation, by setting at rest, for example, any question as to a boiler explosion.

Some of the causes to which the horrible disaster has been attributed may be briefly noted. A submarine explosion has found many advocates, most of whom give as an explanation the strained relations which have existed between this country and Spain, and no basis of fact. That an automobile torpedo was the cause would necessitate the belief that this expensive, cumbrous and delicately adjusted apparatus had been used by skilled naval officers, and that it would be capable of causing such destruction. The first proposition is incredible, and the second is negatived by the results of torpedo explosions as demonstrated in numerous naval encounters in the past.

Another theory is that a submarine mine was exploded under the vessel, either maliciously or by accident. There is certainly a possibility that the Spanish Government had laid mines in Havana harbor in anticipation of any hostile demonstration of an enemy, long before the visit of the Maine to Havana was even suggested. That the Maine in swinging an anchor might have fouled such a mine is not an impossibility, so far as that fact alone is concerned. But would the explosion of a submarine mine have made such a wreck of the Maine as she appears to be? Would the concussion caused by the explosion of a mass of high explosive outside the hull have fired the forward magazines of the vessel? These are questions which cannot be answered off hand. We are informed by Capt. Charles O'Neil, Chief of the Bureau of Ordnance of the Navy, that the Maine had on board no high explosives other than that contained in the heads of the Whitehead torpedoes, which were filled with guncotton. These were stored in the after magazine, abaft the engines, and manifestly were not affected by the explosion, forward, as that portion of the ship was not injured. An inspection of the sectional drawings, which we publish in the accompanying inset, will show very clearly the location of the magazines. We also here present a cross section of the forward magazine at the point where the explosion is supposed to have occurred. The powder contained in the various magazines, included 100,000 pounds of brown prismatic powder, for the big guns, divided between the two main magazines, also 8,500 pounds of coarse black powder contained in the fixed ammunition for the rapid-fire guns, distributed among the magazines, as indicated on the drawings. In the forward magazine there were also 10 in. and 6 in. shells, which contained comparatively small bursting charges, as many of them were of the armor piercing variety, with thick walls. The guncotton, of which there was 800 pounds in the after magazine was kept wet, in which state it is used in action. The dry guncotton, of which a very small quantity was kept on board for exploding the wet, was divided into very minute portions, which were distributed in various places, so that by no possibility could the ignition or explosion of one or more cause anything but slight local damages. The rapid-fire ammunition, including that for the 6-pounders, carried in the forward part of the bow magazine, consisted of the usual form of brass cartridges with primer, powder and projectile in place. It would seem not improbable that any heavy shock, such as the explosion of a mass of high explosive under the bottom, would under certain circumstances cause a discharge of this fixed ammunition. Then this supply of explosive could either be credited with directly causing the horrible loss of life and destruction of property, or of breaking down the steel bulkhead which subdivided the magazine and tearing the coverings of the great gun powder loose, causing a general explosion of the forward magazine. This powder which was of the usual slow burning description was packed in separate charges, contained in flannel bags, which in turn were contained in copper cylinders with slip covers. Some of those who were rescued testify to having experienced two distinct shocks following each other closely. This might seem to bear out the theory of an under water explosion, followed by one within the vessel. An explosion within the vessel would reasonably account for the great mass of fire and flame which accompanied the explosion, as seen by eyewitnesses, and for the breakage of windows and electric lamps in the city of Havana; and also for the tremendous noise, phenomena which do not accompany an exclusively under water explosion, such as the firing of a submarine mine would produce.

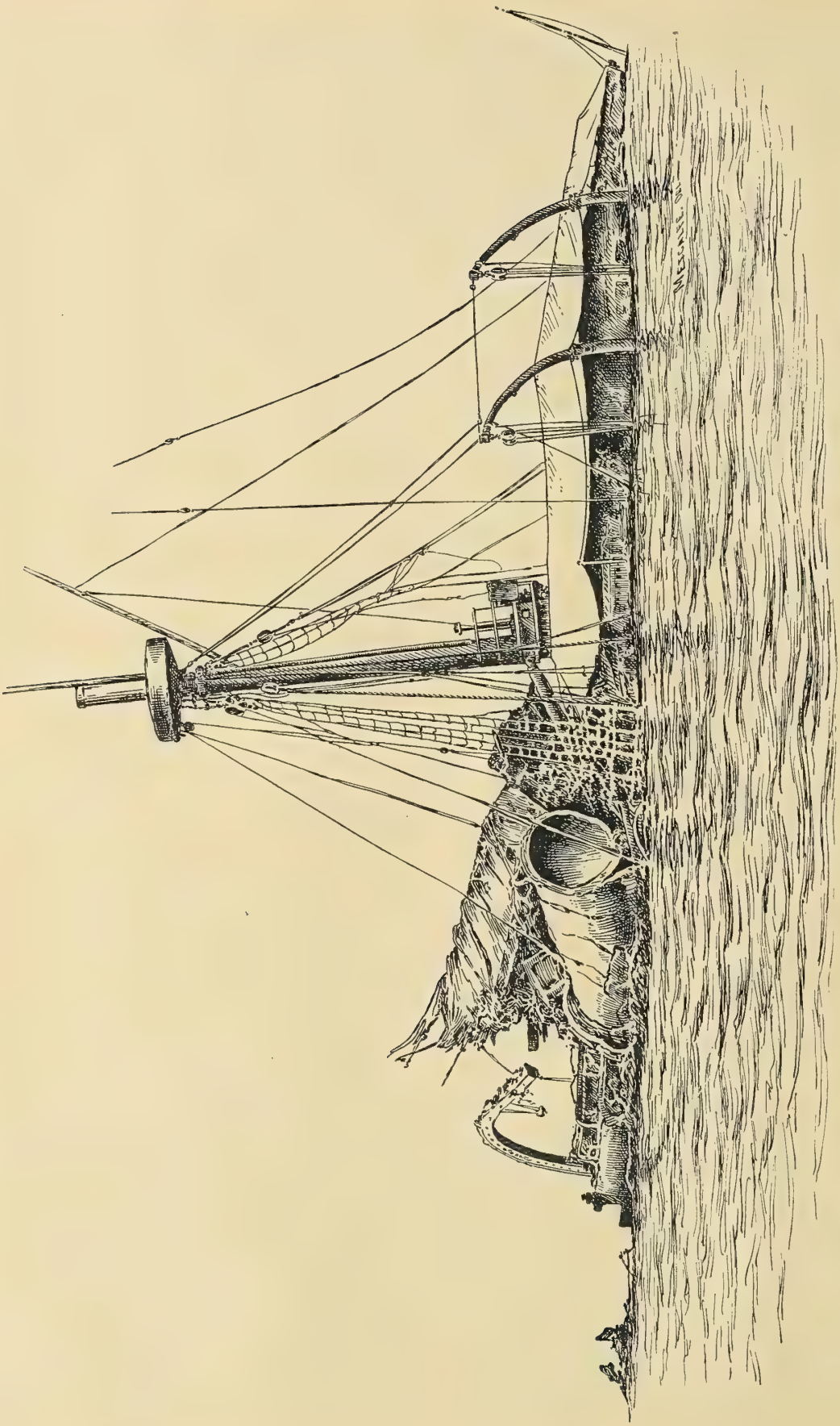
According to authentic reports the Spanish authorities suggested that a "dynamo boiler," had exploded. By this an auxiliary boiler was presumably meant. As a matter of fact, however, the Maine was not fitted with any auxiliary boiler—see description of machinery in this issue. For the dynamo engines connection was made by auxiliary steam pipes with the forward boilers, on the port and starboard sides, adjacent to the dynamo room. This was on the protective deck above the position of the forward magazine, in the hold. One of these boilers, at least, was undoubtedly in use supplying steam to the electric generating plant. Thus it would be under the immediate observation of the engineers of the ship, and it is not for a moment to be supposed that they would permit any conditions to exist in the fire rooms which would cause a disastrous explosion. The boilers were comparatively new, of good design, and built by a firm which has a reputation for good work. When in use for auxiliary purposes they would be worked at a much lower pressure than when supplying steam for the main engines, in which the initial pressure was about 135 pounds. All the boilers would likely be under steam at the time, too, with fires banked, as no warship captain would be likely to be caught in a foreign port, under the circumstances, without steam on. Even granting a boiler explosion possible, the rupture would likely occur at the longitudinal seams, and in this case the cross bunkers would have to be shattered before even the after bulkhead of the forward magazine would be reached. It has been suggested, too, that a bomb containing high explosives might have been hidden in the coal by some fanatic, and when this was thrown into the furnace the explosion followed. Here again the protection which the cross bunkers afforded would have to be considered.

Spontaneous combustion finds many supporters as the prime cause of the disaster. It is of course a possible cause of disaster which has to be taken account of, but consideration of the conditions which prevailed on the Maine are quite

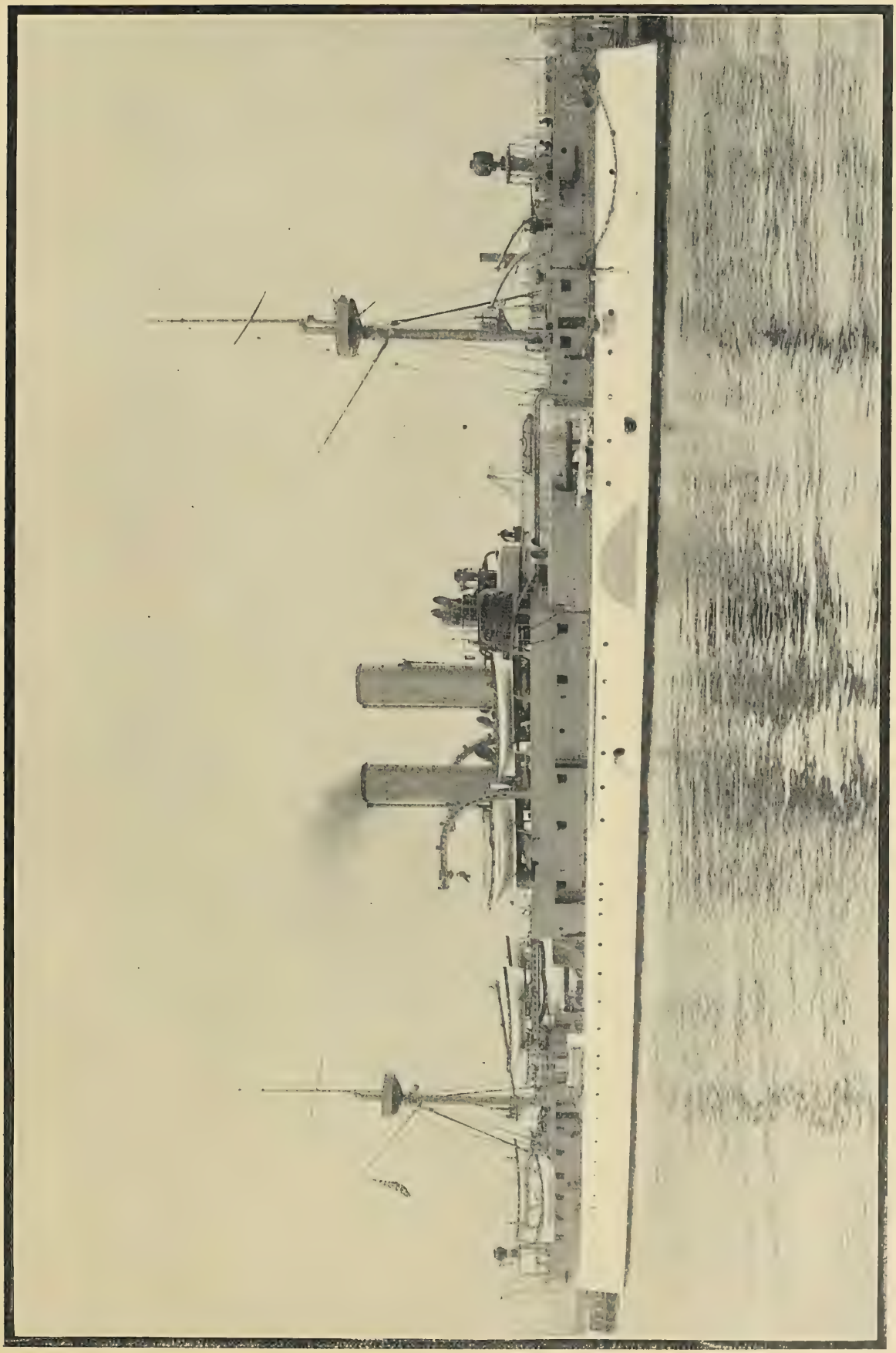


CROSS SECTION OF THE "MAINE" AT THE POINT WHERE THE EXPLOSION IS SUPPOSED TO HAVE OCCURRED.

against this theory. Before her trip to Cuba, the Maine had been using West Virginia bituminous coal, but when she received her sailing orders at Key West, her bunkers are stated to have been filled with hard, or anthracite coal. The total coal capacity of the Maine was 825 tons, which was distributed in twenty coal compartments, principally located along the sides, as protection for the ship's vitals. The bunkers were filled through trunks leading down from the main deck, and escape trunks were arranged to connect the bunkers with the fire room over the boilers, so that the trimmers could pass to and fro when coaling. It will be seen that each bunker was not of great capacity; the cross bunkers, which



WRECK OF THE BATTLESHIP MAINE IN HAVANA HARBOR AS IT APPEARED THE DAY AFTER THE EXPLOSION.



THE LATE U. S. SECOND-CLASS BATTLESHIP MAINE AT THE NAVY YARD, NEW YORK, BEFORE SHE WAS ORDERED SOUTH.

were interposed between the forward boilers and the forward magazine, would contain only about 20 tons each, when filled. Even supposing the Maine had a good many tons of bituminous coal in her bunkers at the time she took in the anthracite coal at Key West, the fact that the hard coal was loaded on top of the soft would tend to bury the latter in the bottom of the bunkers and keep from it whatever air supply might get in. It is not likely, however, that any considerable amount of fresh air passed through the bunkers, and so the little soft coal on board would have small chance of seizing enough oxygen to become dangerous. Again, the Maine had a tendency to trim by the head when loaded, and for this reason the coal in the forward bunkers was invariably used first, so if even these were not emptied they would be under the constant observation of the passers. When coal is heating the condition is made known by a peculiar smell which would not be mistaken by any one accustomed to handling fuel. The cases of spontaneous ignition of coal on the Cruisers Cincinnati and New York, in the former case causing the shell racks in one magazine to char, have been cited. This, however, gives very little guidance in the solution of the Maine disaster. The fires mentioned occurred in bunkers containing soft coal exclusively, and the attendant circumstances and conditions would probably be found to be quite dissimilar, upon examination.

A more plausible theory of origin of the disaster, connecting it with the bunkers, would be that the first explosion was caused by an explosive mixture of inflammable gas and air which had come in contact with a naked light. Certain grades of coal emit an inflammable gas for a considerable time after being mined. This would be given off in increased quantities when the coal was broken, a state which the conditions favored—due to the weight of the fresh supply of hard coal shot into the bunkers. The temperature in the bunkers would likely assist this process, also, as the fire rooms were decidedly warm, and the area of exposed bunker wall considerable. Such a temperature would be too low for the generation of inflammable gas from the coal, but would aid the emission of the gas contained in the coal. A mixture in the proportions, of anywhere from 9 to 15 to 1 of air, would produce a violent explosion upon the application of a naked light. The opening of a bunker lid, or the entrance of a coal passer into a recently opened bunker with a torch might give the needed ignition. These, however, are mere conjectures based on the assumption that a certain kind of coal was present in appreciable quantity.

It is possible that a scientific solution of this mystery may never be reached. If an outer explosion was followed by one from the inside, such as the explosion of the main battery ammunition, the hull conditions would be capable of almost any interpretation. There would likely be some distortion, too, of the frames and plating, by reason of the sinking of the ship at such an inclination that the bow probably touched bottom an appreciable time before the stern came to rest. Even the most careful and dispassionate inquiry may lead up to a wrong conclusion, as was the case in the investigation of the blowing up of H. M. S. Doterel, an account of which will be found on page 13.

Technical Description of the "Maine."

The Maine was originally officially known as a twin screw armored cruiser. She was designed by the Bureau of Construction and Repair of the Navy Department, of which Commodore Hichborn is the Chief, and was built at the New York Navy Yard. As originally drawn, the plans for this ship provided for a considerable spread of canvas on three masts, barque rig. These plans were modified later, however, with the intention of placing the vessel in the battleship class, and thus among other changes, what would have been the main mast was dispensed with and the fore and mizzen masts altered to their military form. This accounts for the great distance apart of the masts which the Maine carried, a feature of design which invariably caused comment. The keel was laid October 11, 1888, and the hull was launched November 18, 1890. In the scale drawings, reproduced in the inset supplement with this issue, the general arrangement and compartment plans are clearly laid out. The hull was of mild steel, divided into 198 watertight compartments, and with a double bottom extending 196 feet (about the distance between the masts) and carried up to the shelf for the armor belt 4 ft. below the water line. In the wake of the double bottom and under the machinery spaces the hull was stiffened by additional longitudinals. The outside keel plate was 5-8 in. thick, inner plate 1-2 in. and the vertical keel 1-2 in.; the outer bottom plating was 1-2 in. thick and the inner bottom 5-16 in. The general dimensions were: Length, between perpendiculars, 310 ft.; over all, 324 ft. 4 in.; breadth, molded, 56 ft. 10 in.; draught, mean, 21 ft. 6 in.; area, immersed midship section, 1,077 sq. ft.; displacement at mean draught, 6,650 tons; tons per inch, 32.32; coefficient of midship section, 0.878 ft.; area of load water line plane, 13,500 sq. ft.; wetted surface, 23,770 sq. ft.

The plan of the hold in the inset supplement shows the exact location of the magazines, which were kept as compactly as possible over the keel line, the main magazines being protected by coal belts. Aft of the collision bulkhead for a distance of 39 ft. there were compartments for wet and dry stores, and then the forward bulk head of the main magazine, extending a distance of 48 ft. In the forward end of this magazine ammunition for the 6 in. guns was stored in a space 12 ft. long and 20 ft. wide, separated from the 6 pounder magazine by a watertight bulk-

head. The 6-pounder magazine containing fixed ammunition was about the same size. These two divisions of the magazine were forward of the armor belt, though of course under the protective deck, and interposed between them and the sides were fresh water tanks and paymaster's storerooms. Abaft the 6-pounder magazine came the 10 in. magazine on the starboard side of the keel line, and the 10 in. shell room and 6 in. magazine to port. This was isolated by watertight bulkheads and extended 24 ft. fore and aft, and 29 ft. athwartships. Wing bunkers were interposed between this portion of the magazine and the sides, and these extended inboard between the magazine walls and the boilers a distance of 8 ft., leaving about 13 ft. of the magazine bulkhead exposed in the fire room. Abaft this magazine the boiler room occupied 87 ft., and then came another magazine, containing 10 in. and 6 in. ammunition, divided by a passage fore and aft leading from the stoke hold to the engine room. The engine room occupied the full width of the ship and extended 35 ft. fore and aft. In the space between the shaft alleys, the after engine room bulkhead and the bulkhead at the outboard shaft bearings, the magazine containing the torpedo heads, small arms ammunition and 6 in. reserve ammunition was located.

The platform deck extended forward and abaft the machinery spaces, and in the space between the boiler and engine rooms. None of the magazines came above this deck, which was situated about 10 ft. below the water line. In the forward end the storeroom and fresh water tanks came up through this deck. The space over the forward magazine was used for storerooms and for the trunks leading up from the magazines. Over the 10 in. magazine was the hydraulic pump room for the forward turret and electrical storeroom. In the deck space between the boilers and engines there were also hydraulic pumps for the after turret, also distilling apparatus, ordnance stores and the necessary trunks and hoists connecting with the magazine below. Abaft the engines, over the magazine, were engineer's, marine and medical and paymaster's stores, and in the center the steering engine room. Here also were entrances to the wing passages which extended along both sides, between the armor belt backing and the bunkers, and which were covered by the protective deck, affording safe communication between the ends of the ship.

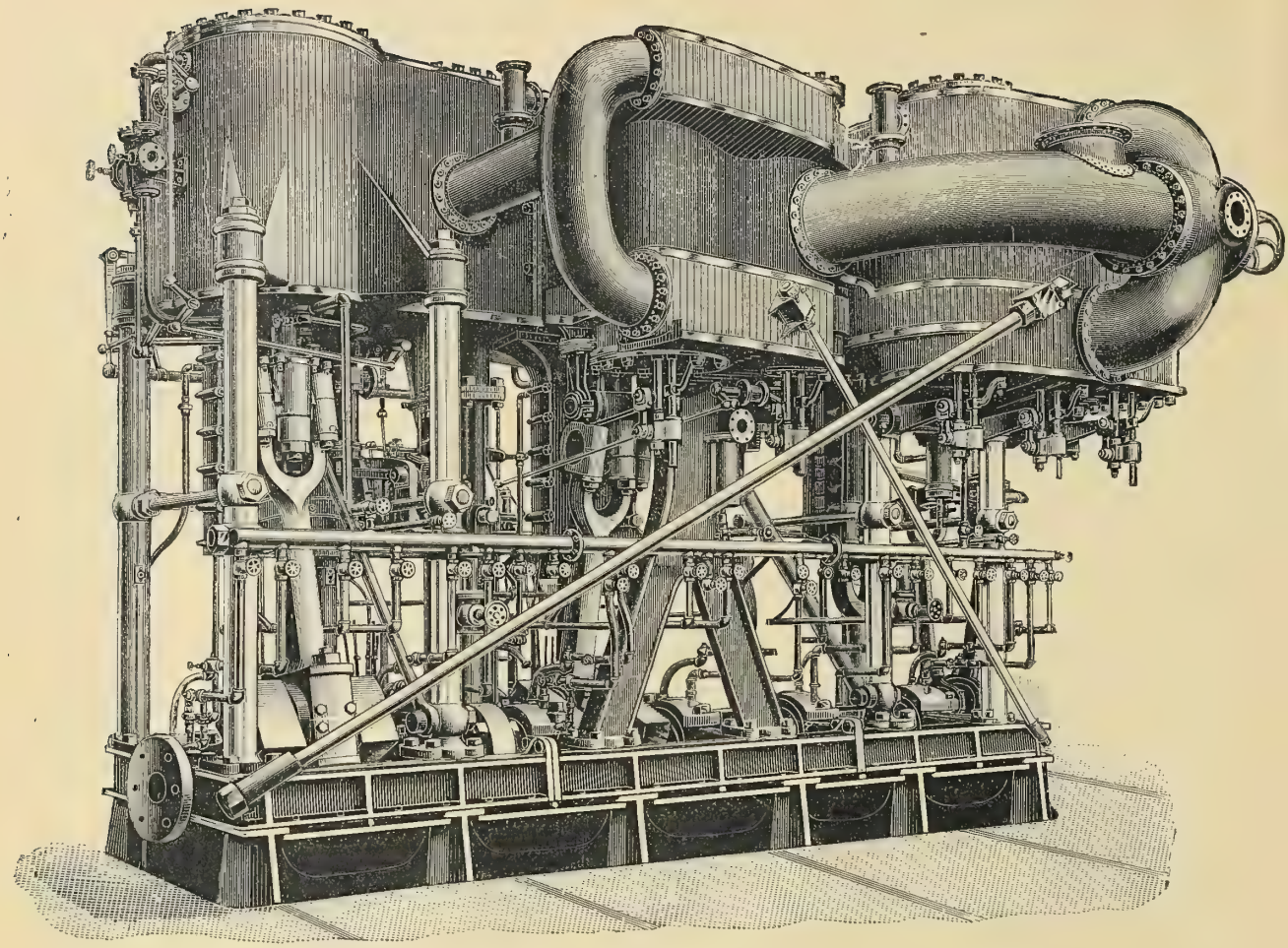
On the protective deck, the forward end of the ship up to the end of the armor belt was taken up with storerooms and chain lockers. Inside the citadel formed by the armor and over the hydraulic pump room, which in turn was over the 10 in. magazine, there was an ammunition passing room in which the magazine trunk hatches were placed. On the starboard side under the forward turret there was a loading room, which is clearly shown in the cross section at frame 24, which we here publish. Between this loading room and the port forward wing bunker came the dynamo room. Over the center line and between the dynamo room and the boiler room, and protected by the inboard bunkers before referred to the central station was fitted. This was immediately under the conning tower, with which it was connected by an armor tube. In this station connection was made between the various electrical and other signal apparatus in the conning tower and the various points throughout the ship where orders or communications were needed. Between the boiler and engine rooms on this deck the steam mains were carried, and on the port side below the after turret there was a loading room, and hatches opening into the magazine below. The after end on this deck, abaft the armor belt, was used for stores; both ends were protected by belts of cellulose which in fact formed a continuation here of the armor belt, fore and aft. Passages on this deck also extended the length of the armor belt, fore and aft.

On the berth deck the living quarters were located. Forward and amidships were the crew spaces, and on the port side abreast of the forward turret the sick bay. On this deck there were four torpedo tubes. One was situated on the starboard side just forward of the turret. Two tubes were placed on opposite sides about abreast of the smoke pipes, and the fourth tube was in position abaft the turret on the port side. In the center of the ship on the starboard side there was an engineer's workshop. Variously disposed on this deck were the various officer's mess rooms, ward room and officers' state rooms.

On the main deck the batteries of heavy guns were carried. Here also was the windlass and anchor gear forward, within the superstructure. In the superstructure amidships there was the crew's mess room, galley, signal room and armory. In the after superstructure there was a large saloon and captain's cabin and executive officers' offices.

On the superstructure deck forward a powerful search light was fixed at a considerable elevation. Here also the various boats were carried. The conning tower was situated just in front of the forward funnel, and above this there was a chart house surmounted by a rail and fitted with compasses and indicators, so that it could be used as a platform from which to navigate the vessel.

In detail the armor consisted of a belt of Harveyized steel extending about 180 ft. amidships and 3 ft. above and 4 ft. below the water line. It was 12 in. thick from the top to a space of 12 in. below the water line, and from there it tapered to 7 in. at the armor shelf. It was backed by 8 in. of teak, behind which were two thicknesses of 1-2 in. plating very thoroughly stiffened by angle bars and plates. At the forward end of the armor belt there was an athwartship 6 in. steel bulkhead with wood back. This inclosed space was covered with a protective deck of two layers of 1 in. steel, which sloped down below the water



FRONT VIEW OF THE TRIPLE-EXPANSION ENGINES OF THE "MAINE."

line at the after end of the side belt. The turrets on the main deck were of 8 in. Harveyized steel armor, strongly backed, and the revolving mechanism and gun platforms were protected by a fixed barbette of mild steel 12 in. thick. The conning tower, elliptical in shape, was 10 in. thick, connected with the central station below by a 4 1-2 in. armored steel tube.

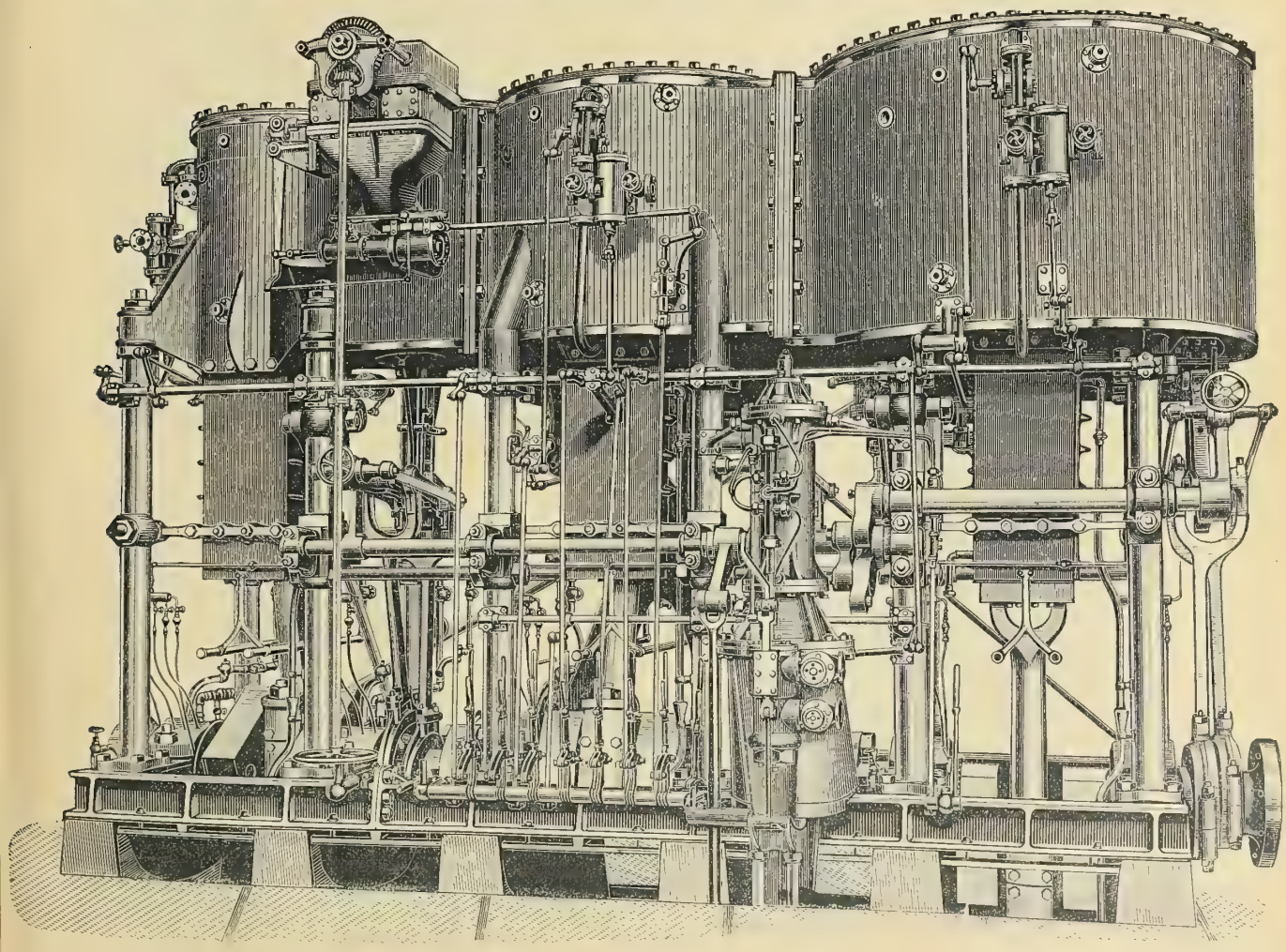
The armament consisted of four 10 in. breech loading rifles, two in each turret, also six 6 in. breech loading rifles, two placed in the forward superstructure, and two in a similar position aft, and one on each side amidships. These guns were operated by hand gear and protected by 2 in. steel shields.

The 6 in. guns forward and aft could be fired parallel with the keel line, or all could be fired broadside. The 10 in. guns could also be fired ahead or astern according to their respective positions. The guns in each turret could also be fired across the decks through an angle of about 60 deg. With all the guns trained for broadside fire a total weight of projectile of 4,800 pounds could be obtained at one discharge. The secondary battery included seven 6-pounder, eight 1-pounder rapid fire, and four Gatling guns. Four Whitehead torpedo tubes were fitted with eight torpedoes.

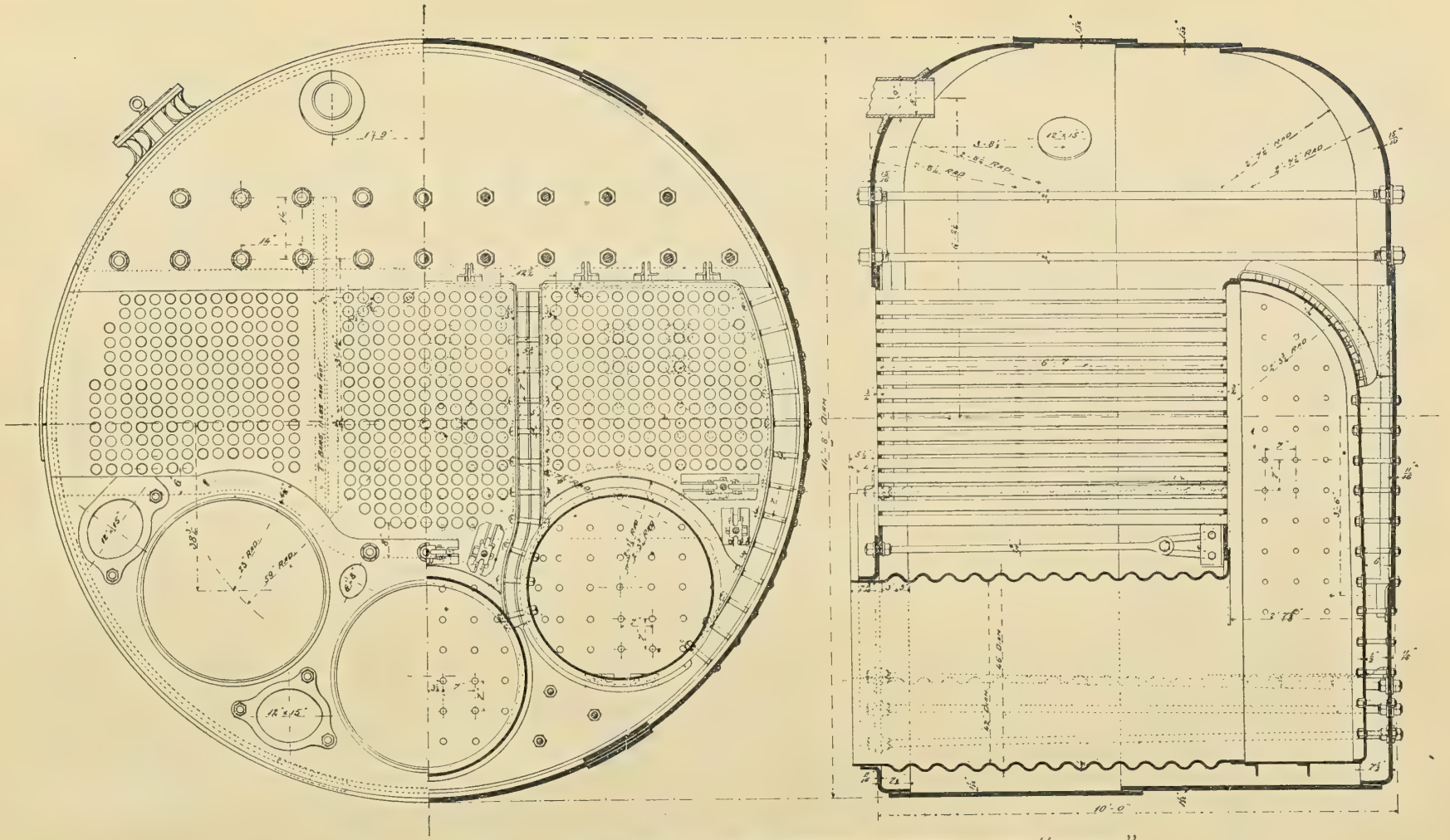
Machinery Equipment of the "Maine."

The machinery of the Maine was built by the Quintard Iron Works, New York, from designs prepared under the supervision of Commodore Melville, Chief of the Bureau of Steam Engineering. There were two sets of triple-expansion engines, exact engravings of which both front and back, we present on this and the opposite page. They were arranged in separate engine rooms, divided by a fore and aft bulkhead, which reached up to the steel protective deck. The cylinders were 35 1-2 in., 57 in. and 88 in. dia., and 36 in. stroke. Steel was used for the bedplates which were in three sections bolted together. The frames were hollow forged steel columns, with the exception of the front column of the I. P. cylinder, which, in each engine, consisted of a single inverted Y steel column. Horizontal and diagonal steel braces were used for staying the columns. The cylinders were placed in order from forward aft, L. P., I. P. and H. P., and the piping was so

arranged that the L. P. cylinders could be disconnected, and with the H. P. and I. P. only in use the engines worked compound. All the cylinders were jacketed. Piston valves of the single ported type were used throughout, one for the H. P., two for the I. P., and three for the L. P. cylinders, all of 22 in. dia. Stephenson link motion with double bar links was used for all, the H. P. valves being worked direct and the I. P. and L. P. valves by rock shafts. Balancing pistons were provided for the H. P. valves. Single slide crossheads were used, the slippers working in composition guides 22 in. long and 20 in. wide. The pistons were of composition, with rods of forged steel, 6 1-4 in. dia., the bottom end of each rod forming a crosshead, fitted with an adjustable brass and composition cap. Connecting rods were also steel forgings, each 6 ft. long between centers, with forked crosshead ends, and the usual through bolted crank ends. The crank shafts were in three interchangeable sections, with forged couplings. Two bearings were provided for each section. They were 13 in. dia. and 23 ft. 3 in. long, with a 4 in. hole, and with seatings for the eccentric sheaves 13 1-2 in. dia. The cranks were set 120 deg. apart, in regular sequence, with webs 17 1-2 in. wide and 9 in. thick, and with pins 14 in. dia., 14 in. long and with 4 in. through holes. Steam reversing gear with hydraulic controlling cylinders was fitted for each engine. All the main brasses were lined with Parson's white metal and very complete arrangements for lubrication were in place. Distributing tanks were fitted on the sides of the cylinders, supplied with oil by a pump from the main tanks. The crank pins were also provided with centrifugal oil feeding devices, and sight feed cups were attached to the live steam pipes on the main engines and auxiliaries. The main stop valves could be worked either from the engine room or the berth deck, and screw stop valves were also arranged so that both engines could be controlled, if necessary from either engine room. The thrust shafts were 12 ft. 5 in. long, 12 3-4 in. dia., and with 6 in. through holes. Each was fitted with 11 collars 17 1-4 in. outside dia., 2 in. deep, and 1 5-8 in. thick, spaced 2 1-8 in., giving a thrust surface of about 1,000 sq. in. The forward propeller shafts were 21 ft. long, 13 3-8 in.



BACK VIEW OF THE TRIPLE-EXPANSION ENGINES OF THE "MAINE."



SECTIONAL DRAWINGS OF THE SINGLE-ENDED SCOTCH BOILERS OF THE "MAINE."

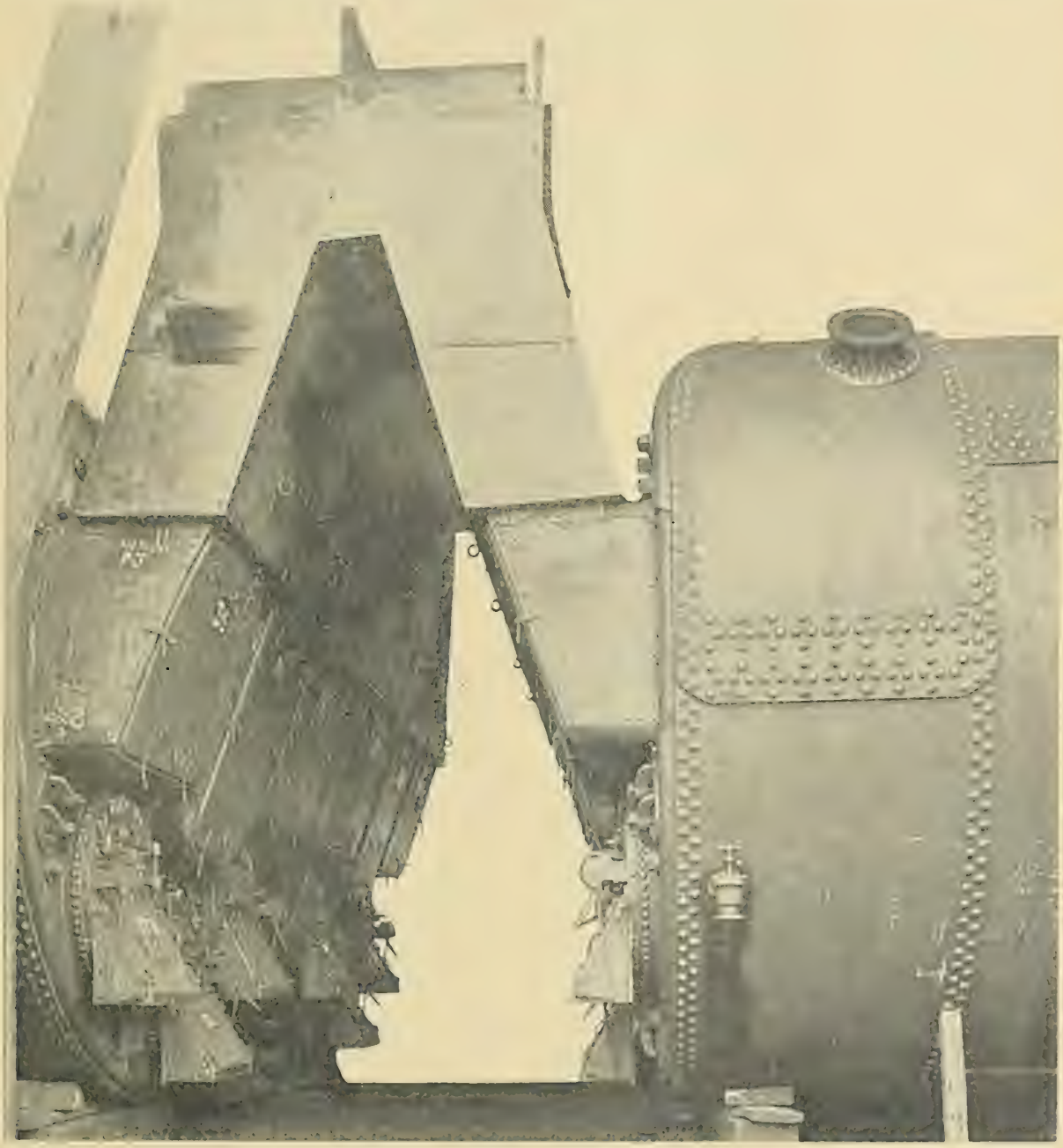
dia., with a 6 3-4 in. hole, and the after shafts 27 ft. long, 13 1-4 in. dia., with a 6 1-2 in. hole. Where they passed through the stern tubes and stern brackets, they were cased in composition 3-4 in. thick. The total length of shaft for each engine was 84 ft. 3 in.

Manganese bronze was used for the propellers, which were four bladed, true -screws with adjustable blades, spherical hubs, and conical tail pieces covering the tap bolt heads. The propellers were 14 ft. 6 1-2 in. dia., and normally 16 ft. pitch. The distance of tail shaft centers from bottom of keel was 8 ft. 1 in., and immersion of tip of blades at normal draught 6 ft. 2 in.

Composition was used for the condenser shells of which there was one in each engine room. They were 10 ft. 5 in. long, 6 ft. 6 in. dia., and each contained 5,141 tubes, giving a total cool-

ing surface for each of 7,000 sq. ft., or a ratio of cooling surface to total heating surface of 1 to 1.35. The circulating water was passed through the tubes. Each condenser was arranged so that it could be used as an auxiliary condenser, using an auxiliary centrifugal circulating pump. Independent main combined air and circulating pumps were fitted. The air pumps were double, vertical, single-acting, connected to a horizontal double-acting circulating pump, all worked by a horizontal tandem compound engine, with cylinders 12 in. and 24 in., and a common stroke for steam and water cylinders of 18.5 in. The air pump cylinders were 30 in. dia., and circulating pump cylinders 31 in. dia.

There were eight single ended Scotch boilers of the Navy pattern, in two groups of four each, placed in separate watertight compartments. The boiler fronts were inboard, and they were fired athwartships. Detail drawings which are here reproduced (page 10) clearly show the design. The uptakes connected each group of boilers with one smoke pipe, internal division plates being used to keep the gases from each boiler separate. Each boiler was 14 ft. 8 in. dia. and 10 ft. long, with three corrugated furnaces



FORWARD FIREROOM BOILERS OF THE "MAINE" SET UP IN BUILDERS' YARD.

42 in. dia. They were built for a working pressure of 135 pounds, and were tested to 225 pounds by the application of heat to water. The grates were 6 ft. 10 in. long. Each boiler was fitted with 401 ordinary tubes, and 118 stay tubes, 2 1-4 in. outside dia. The steam room in each boiler when the water was 6 in. above the tubes was 374 cu. ft., and the contained water 40,828 pounds. There was an 8 in. admiralty type, self closing stop valve on each boiler, and auxiliary stop valves 5 in. dia. were placed on each of the two forward and two after boilers. Two 4 1-2 in. spring safety valves were fitted to each boiler. For the eight boilers the total grate surface was 573.84 sq. ft.; total tube heating surface 16,101.11 sq. ft., plate surface 2,914.23 sq. ft., or a total of all heating surface of 19,015.34 sq. ft. The ratio of total heating surface to grate surface was 33.137 to 1. The smoke stacks were 75 ft. above the lower grates, and the area of each was 40.27 sq. ft. In the reproduction of the photograph of one set of boilers set up in the builder's yard the arrangement of the fittings will be observed.

Forced draft on the closed ash pit system was installed, with Sturtevant blowers discharging into proper ducts fitted with dampers. These could be regulated by hand, and they also automatically cut off the draft when a furnace door was opened. The blowers were arranged to take their supply from the stoke hold, creating an inrush of fresh air through the gratings into the fire room. Two blowers were fitted, each capable of discharging 25,000 cu. ft. of air per minute when running at 550 revolutions. They were driven direct by Sturtevant engines.

A considerable number of auxiliaries were fitted in the vessel. In each fire room there were two vertical duplex double-acting feed pumps, one for the main and one for the auxiliary feed. The auxiliary pumps were arranged for a variety of uses, including that of fire pumps. The pumps had steam cylinders 10 in. dia. and 6 in. water ends, and 12 in. stroke. A feed tank containing 550 gallons was fitted in each engine room, with a filter arrangement through which the feed water was passed. Other pumps were fitted for bilges, drains and for the engine room water pipes, and for fire purposes. A jacking engine was geared to each main engine. There were also ventilating fans for the engine rooms and crew spaces on the berth deck. In the after part of the ship, below the water line, a combined steam and hand steering gear was placed, and this could be variously operated from the conning tower, flying bridge, pilot house, superstructure deck, or from the steering engine room. The powerful windlass and capstan on the main and superstructure decks was also operated by steam, various winches, workshop engine, and distilling apparatus also made demands on the steam supply.

The hydraulic plant was extensive, including apparatus for turning the turrets, loading and working the guns, and for hoisting ammunition. The position of these sets of machinery, one for each turret has already been indicated. By a duplication of the pressure piping, each of these plants could be used to operate both turrets. In each set there were two horizontal duplex pumps, connected with a steam accumulator, with a capacity of 550 gallons a minute at a pressure of 600 pounds, the pumps taking steam at 100 pounds pressure. The turning engines were of compact design of the single acting oscillating cylinder type, geared to the circular turret turning rack. An air compresser was also included in the machinery outfit for supplying air for the torpedoes gear.

The lighting plant consisted of two generating sets, with four pole compound wound dynamos driven direct by vertical engines, with cylinders 13 1-2 in. by 6 in. stroke. The dynamos developed 400 amperes at 80 volts, and furnished current for 500 16-candle power incandescent lamps, four searchlights of 60,000 candle power, and two of 80,000 candle power, and for a small motor driving a fan for ventilating the dynamo room.

Trial Trips of the "Maine."

The trial trip of the Maine was run in October, 1894, in Long Island Sound. The object was to determine the horse power, and the run was for four consecutive hours. There was a strong head wind and sea, and the average speed was nearly 16 knots, though allowing for wind and tide, the speed figured out 17.45 knots. This trial was very successful, so far as the behavior of the ship and the working of the machinery were concerned. The trial draught forward was 18 ft. and aft 19 ft., and the displacement 5,500 tons. With a boiler pressure of 145 pounds the engines made 123 turns. Forced draught was used, the air pressure in the ash pits reaching 1.074 in. The indicated horse power of the starboard engine was 4,696.95 and of the port engine 4,474.50, or 9,171.45 for both engines, and for all machinery, including pumps, blowers and auxiliaries, 9,292 indicated horse power. This showed 2.0462 sq. ft. of heating surface per I. H. P. and 1.5087 sq. ft. of cooling surface, and 16.1938 indicated horse power of all machinery in operation per sq. ft. of grate surface. The indicated horse power per ton of propelling machinery, including boilers and contained water, was 14.18. Pocahontas coal was used, and the consumption was 35.327 pounds per sq. ft. of grate surface, and per indicated horse power of all machinery, 2.1815 lbs.

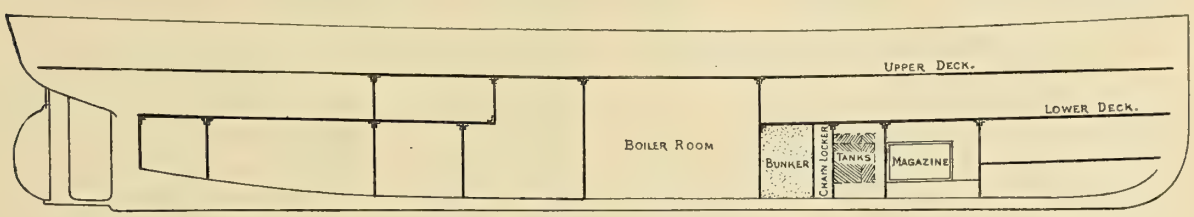
When in commission, and using Pocahontas coal, a coal trial of the Maine at cruising speed was made. Her bottom was clean and the weather during the trial, which lasted almost one day, was fine. Using half her boiler power, the engines making 74 turns, developed 1,697 horse power, and a speed a small fraction in excess of 11 knots was maintained. The horse power coal consumption was 2.22 pounds and the consumption for all purposes was 5.84 pounds per knot.

Fatal Explosions on British Warships.

In the history of naval disasters, leaving out of consideration those due to intentional submarine explosions, or those in which accidental gun explosions occurred, there are two cases which are of special interest at this time. It is not so much that they parallel the Maine disaster as to the origin of the explosion but to similarity in other respects that a recollection of them is timely. The disasters referred to both occurred to British naval vessels; one the explosion of a main boiler on H. M. S. Thunderer, in July, 1876, and the other the blowing up of H. M. S. Doterel, in April, 1881.

The Thunderer in her day was one of the most powerful battleships in the British Navy. She is a double-turreted ship, 285 ft. long, 62 ft. beam and of 9,190 tons. Her hull was constructed at the Pembroke Royal Dock Yard, and was launched in 1872. Her machinery was built by the famous English firm of Humphrey & Tennant, and consisted of low-pressure twin screw horizontal engines of 5,600 H. P., and eight rectangular wet-bottom boilers. These were set in two fire rooms, much the same style as the boilers of the Maine, and each boiler measured 15 ft. 3 in. in a fore and aft direction, 13 ft. high, and 10 ft. 6 in. athwartships. Each had four furnaces. They were built to work at 30 pounds pressure. After the ship was completed as to her machinery, there was for some reason a considerable delay in getting her ready for sea. It was in July, 1876, that she went to sea on a contractor's trial. She had started a full speed run, when those on deck were startled by a noise, which was afterwards described as like the sound of an explosion of a mining charge, or torpedo under water. Clouds of steam immediately came up through the gratings. An investigation showed that one of the starboard boilers had burst, the steam space in the front of the boiler having been blown out, shearing the rivets and tearing the plates in places. Fifteen men were taken out of the stoke hold, dead, and of those injured, twenty-four subsequently died. An inquest was held, and exhaustive investigations made by the ablest engineers in England to discover the cause of the accident. The Coroner's jury found that the explosion was caused by the sticking of the safety valves, due to contraction of their seats. There were two valves on the boiler, of an old form, loaded with weights. In the evidence it was shown that by some unaccountable error the stop valve of the boiler had either not been opened at all, or had been closed during the run. The steam gauge was proved also to have been defective, and at the time of the explosion did not register more than 18 pounds, whereas experts believed the boiler was not ruptured until 100 pounds was reached.

The loss of the British cruiser Doterel, with 8 officers and 133 men, on April 26, 1881, caused a tremendous sensation in naval circles. She was a new vessel, built of wood, with iron frames, 170 ft. long, 36 ft. beam, and 14 1-2 ft. draught, and was an unusually strong vessel. She was barque rigged, depending chiefly on sail for propulsion, though she had a single screw, with compound engines of about 1,000 horse power. She had three boilers 7 ft. 9 in. dia., fitted in a fore and aft position on the keel line. When she blew up she was at Sandy Point, in the Straits of Magellan. She had a crew of about 140 men, and considering the few who survived, the terribly fatal character of the mishap can be understood. The survivors reported that there were two distinct shocks, following each other at an interval of about 20 seconds, much the same as occurred on the Maine. The first explosion was apparently not so severe as the second, for after this she sank almost instantly in 50 ft. of water, there being no time even to launch a boat. As in the case of the Maine, also, other vessels lying near were not injured in the least. The explosions occurred forward, the first on the starboard side, and the second the magazine, the position of which is here indicated in the sketch. It will be noted that the fore magazine was separated from the boiler room by a coal bunker, chain locker and water tanks, each of which in turn was separated by iron bulkheads extending to the upper deck. The tops of the boilers came above the lower deck, in which were the magazine hatches. The bunker capacity was about 140 tons of coal, and as she used sails mostly, this was likely to be filled with one supply of coal for a considerable time.



PROFILE OF H. M. S. DOTEREL, SHOWING LOCATION OF MAGAZINE, FORWARD.

Several theories were immediately put forward as to the cause of the disaster. Some asserted that a torpedo had exploded in the magazine, others that she had fouled a torpedo laid down during the then late Chilian-Peruvian war, and again others, that one of her boilers had exploded and set off the magazine. Many contended that a Fenian emissary had introduced a bomb into the coal supply.

In the inquiry which followed it was ascertained that she was about to take on coal, and that the bunker lids had been raised, and that these were adjacent to the galley in which a fire was burning. After a lengthy consideration of the case the Board of Inquiry decided that the first explosion was caused by an explosion of bunker gas, and that this set off the forward magazine.

Every one was satisfied with this explanation, until in November of the same year a mysterious explosion occurred on board H. M. S. Triumph. This occurred in the paint room, while she was lying at Coquimbo, and caused the death of two of the crew, and more or less severe injuries to eight others. Captain A. H. Markham in his report after the disaster expressed his opinion that it was due to the storage of a keg of xerotine siccative in the glory hold, under the paint room. This is a high sounding classical name for a composition used by painters, and commonly known as "patent driers." It is composed largely of benzoline, and as its name would indicate is put in paint to make the coat dry quickly. It possesses the property also of giving off highly explosive gas or vapor which only needs the contact of a naked light to produce disastrous results, which are only limited by the amount of vapor present and the strength of the enclosing structure. The Court of Inquiry, after an exhaustive examination, confirmed the opinion of Capt. Markham as to the cause of the Triumph explosion.

This at once recalled the destruction of the Doterel, and some of the survivors of that terrible affair came forward and testified that a large jar containing xerotine siccative had been kept on the Doterel in the vicinity of the magazine. The jar had leaked badly, and a considerable quantity of the drier had escaped before the leak was discovered and the jar thrown overboard. Thus the real cause of the blowing up of the Doterel was discovered in an accidental way.

These accidents and others of a less disastrous character caused the British Admiralty to commence a long series of investigations into the subject of explosions on war vessels. Orders were also issued to get rid of all the xerotine siccative on vessels, and that no new compounds should be issued by any departments until they had been chemically examined and reported upon as to their explosive qualities. The investigations pursued by the committee of experts resulted in a recommendation that the ventilation of coal bunkers in vessels should be kept separate from the system used for ventilating other portions of the vessel, and that it should be continuous. This necessitated not only means for admitting currents of air, but means of escape for any gases that might be evolved.

On the committee Engineers, Chemists and Constructors, possessed of the very highest scientific attainments, were included. Many practical tests were made.

Concerning Naval Discipline.

When the news of the Maine disaster was first cabled abroad it called forth criticisms upon the American Navy, in some quarters, which were as extremely ridiculous in the one direction as the bombastic blatherskite printed in many home papers was in the other. The St. James Gazette of London, was inclined to the belief that the loss of the ship was caused by an explosion in the magazine, adding:

It remains, however, to be explained how a magazine carefully guarded could be fired. As bearing on this, however, it must be borne in mind that the discipline on American war ships is to English ideas rather lax.

Apparently the St. James Gazette has forgotten the blowing up of H. M. S. Doterel, and the evidence which was given at the subsequent investigations? W. B. Baird the carpenter of the Doterel, testifying before the inquiry committee at Portsmouth dockyard, was asked, with reference to the leakage of xerotine siccative in the masthole forward, and which occasioned the explosion:

Q.—Where did you mess on board the Doterel?
A.—In the fore compartment.
Q.—Was the smell very strong, so that all the men would notice it?
A.—It was very strong, as soon as you came on the mess deck ladder, and all of them were talking about it the night before. The smell was awful.

Yet with all the men "talking about it" the officers do not seem to have had anything to say and it was left to the plumber's mate to throw overboard the leaking jar of the explosive, too late, however, to prevent the immediately following explosion. Again in the inquiry into the cause of the fatal explosion, caused by xerotine siccative, on board H. M. S. Triumph, at Coquimbo, in the same year, Mr. Goodwin the carpenter in his examination was asked by his commander, Captain A. H. Markham:

Q.—Were the orders of the ship relative to the use of naked lights in the paint room to your personal knowledge strictly carried out?
A.—On all occasions *strictly enforced but not carried out.* On one or two occasions the painter has been punished for having a naked light in the paint room.

Captain Markham himself in his observations concerning the explosion wrote:

I deeply regret that for some *incomprehensible reason* we, on board, were not in possession of more explicit information regarding the exceedingly dangerous and explosive nature of this composition (xerotive siccative) before it was authorized to be issued to us as ship's stores. * * * No one but the painter, or those acting under his orders, has access to the paint room during the day, and strict orders were, and are, in force regarding the use of naked lights in that particular compartment. In fact, the painter himself had been punished for carelessness in using a naked light in the paint room only a month ago.

Now if these facts are the results of "English ideas," and the statement of the St. James Gazette be true, surely the conditions on the Maine must have been awful! Probably the crew of H. M. S. Calliope could give our contemporary some pointers about discipline on vessels of the American navy.

Vessels of U. S. Navy on the Active List.

The Maine disaster has had the effect of increasing the interest of those engaged in maritime affairs in the strength and efficiency of the Navy. Most, if not all, of the vessels on the active list are known by name, but frequently the type of vessel is not so familiar and for this reason a statement of the chief characteristics of the seagoing ships of the Navy is of special importance, for information and ready reference. The following list is prepared from the latest official data, and includes all vessels built or building other than a few obsolete wooden steam and sailing vessels, which represent memories of the past rather than possibilities of the future. There are nearly a dozen such steam vessels and half a dozen sailing vessels, which are variously employed in work—such as receiving ships at various naval stations or training ships for the naval militia.

In the first, or battleship division of the Navy list, there are included the battleships Kearsarge, Kentucky and Illinois, under construction at the Newport News yard, the Alabama building at Cramps, and the Wisconsin at the Union Iron Works in San Francisco. The dates set for completion of these ships extend throughout the year 1899, but owing to the armor plate dispute between the Government and the steel makers, it is not probable that all will be in commission by 1900. The battleships now on the active list have all been put in commission in the years 1895 and 1896, so that they are quite modern in design, construction, and equipment, with the single and important exception of their main batteries. The Iowa alone is equipped with rapid-fire guns in her main batteries, though these are of medium caliber—six 4 in. rapid-fire guns. The rapid-fire guns on the other ships are contained in the secondary batteries, of the 6-pounder type. In this respect as in all others the armored cruisers Brooklyn and New York represent the highest type of fighting machines of their class, having main batteries well supplied with the rapid firing type of guns, and possessing great speed and endurance, with adequate armor protection. Several of the torpedo boats are not yet completed, but work on nearly all could be so hurried that they would be quickly ready for service.

In the division of Iron and Wooden Steam Vessels there are included several ships which, of course, would not be available for any offensive operations in time of war. The Michigan, for example, built in 1844, is probably the oldest iron steamer afloat, and is engaged in special service on the Great Lakes. These vessels must, however, be considered as additional to the fighting fleets, filling quite important services, and their counterpart can be found in the fleet of, probably, every naval power.

Armament and armor have not been gone into in this list, as this would introduce a mass of detail which would complicate the descriptions and defeat the purposes of ready reference. It may be taken for granted that the vessels in each division are equipped in these respects, in conformity with the practice usual in the class to which they belong.

Three torpedo-boat destroyers recently contracted for are included in the list, though, of course, these have not got beyond the preliminary stages of construction.

BATTLESHIPS.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Indiana	348.0	69 3	24.0	10,288	15.547	9,738
Iowa	360.0	72.2½	24.0	11,410	16.	11,000
Maine	318.0	57.0	21.6	6,682	17.45	9,293
Massachusetts	348.0	69.3	24.0	10,2-8	16.21	10,403
Oregon	348.0	69.3	24.0	10,288	16.79	11,111
Texas	301.4	64.1	22.6	6,315	17.	8,000
Kearsarge	368.0	72.5	23.6	11,525	16.	10,000
Kentucky	368.0	72.5	23 6	11,525	16.	10,000
Illinois	368.0	72.5	23.6	11,525	16	10,000
Alabama	368.0	72.5	23.6	11,525	16	10,000
Wisconsin	368.0	72.5	23.6	11,525	16	10,000

ARMORED CRUISERS.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Brooklyn	400.6	64. 8¼	24. 0	9,271	21.91	18,769
New York	380.6½	64.10	23.10	8,200	21.	17 401

ARMORED RAM.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Katahdin	250.9	43.5	15.0	2,155	16.11	5,068

ARMORED DOUBLE TURRET MONITORS.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Amphitrite	259.6	55.10	14. 6	3,990	10.5	1,600
Miantonomoh	259.6	55.10	14. 6	3,990	10.5	1,426
Monadnock	259.6	55.10	14. 6	3,990	12.0	3,000
Monterey	256.0	59. 0	14.10	4.084	13.6	5,244
Puritan	289.6	60. 1½	18. 0	6,060	12.4	3,700
Terror	259.6	55.10	14. 6	3,990	10.5	1,600

ARMORED SINGLE TURRET MONITORS (IRON).

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I.H.P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Ajax	225.0	43.8	13.6	2.100	5 to 6	340
Comanche	200.0	46.0	11.6	1,875	....	340
Canonicus	225.0	43.8	13.6	2,100	....	340
Catskill	200.0	46.0	11.6	1,875	....	340
Jason	200.0	46.0	11.6	1,875	....	340
Lehigh	200.0	46.0	11.6	1,875	....	340
Mahopac	225.0	43.8	13.6	2,100	....	340
Manhattan	225.0	43.8	13.6	2,100	....	340
Montauk	200.0	46.0	11.6	1,875	....	340
Nahant	200.0	46.0	11.6	1,875	...	340
Nantucket	200.0	46.0	11.6	1,875	....	340
Passaic	200.0	46.0	11.6	1,875	....	340
Wyandotte	225.0	43.8	13.6	2,100	....	340

UNARMORED STEEL VESSELS.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I.H.P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
PROTECTED CRUISERS—						
Atlanta	271 3	42.1¾	16.10	3,000	15.60	4,030
Baltimore	327.6	48.7½	19. 6	4,413	20.096	10.0 4
Boston	271.3	42.1¾	16.10	3,000	15.60	4.030
Charleston	312.7	46.2	18. 7	3,730	18.20	6,666
Chicago	325.0	48.2	19. 0	4,500	15.10	5,084
Cincinnati	300.0	42.0	18. 0	3,213	19.	10,000
Columbia	412.0	58.2¼	22. 6½	7,375	22.8	18,509
CRUISERS—						
Detroit	257.0	37.0	14. 7	2,089	18.71	5,227
Marblehead	257.0	37.0	14. 7	2,089	18.44	5,451
Montgomery	257.0	37.0	14. 7	2,089	19.05	5,580
PROTECTED CRUISERS—						
Minneapolis	412.0	58.2¼	22. 6½	7,375	23.073	20,862
Newark	310.0	49.2	18. 9	4,098	19.	8,869
Olympia	340.0	53.0⅝	21. 6	5,870	21.686	17,313
Philadelphia	327.6	48.7½	19. 2 ½	4,324	19.678	8,815
Raleigh	300.0	42.0	18. 0	3,213	19.	10,000
San Francisco	310.0	49.2	18. 9	4,098	19.525	9,913
GUNBOATS—						
Bennington	230.0	36.0	14. 0	1,710	17.5	3,436
Castine	204.0	32.1½	12. 0	1,177	16.032	2,199
Concord	230.0	36.0	14. 0	1,710	16.8	3,405
Helena	250.9	40.1⅜	9. 0	1,392	13.0	1,600
Machias	204.0	32.1½	12. 0	1,177	15.46	2,046
Nashville	220.0	38.3	11. 0	1,371	14.0	1,750
Petrel	176.3	31.0	11. 7	892	11.79	1,095
Wilmington	250.9	40.1⅜	9. 0	1,392	13.0	1,600
Yorktown	230.0	36.0	14. 0	1,710	16.14	3,392
COMPOSITE VESSELS—						
Annapolis	168.0	36.0	12. 0	1,000	12.	800
Vicksburg	168.0	36.0	12. 0	1,000	12.	800
Newport	168.0	36.0	12. 0	1,000	12.	800
Princeton	168.0	36.0	12. 0	1,000	12.	800
Wheeling	174.0	34.0	12. 0	1,000	12.	800
Marietta	174.0	34.0	12. 0	1,000	12.	800
SPECIAL CLASS—						
Bancroft	187.6	32.0	13. 4	976	14.37	1.213
Dolphin	240.0	32.0	14. 3	1,486	15.50	2,253
Vesuvius	252.4	26.6⅜	10. 7½	929	21.42	3,795
TORPEDO BOATS—						
Cushing	138.9	14.3	4.10⅜	105	22 5	1,720
Ericsson	149.7	15.6	4. 9	120	24.	1,800
Stiletto	88.6	11.0	3. 0	31	18.22	359
Foote	160.0	16.0¾	5. 0	142	24.5	2,000
Rodgers	160.0	16.0¼	5. 0	142	24.5	2,000
Winslow	160.0	16.0¾	5. 0	142	24.5	2,000
Porter	175.0	17.0	5. 6	....	27.5	....
Dupont	175 0	17.0	5. 6	....	27.5	....
Rowan	170.0	17.0	5. 6	182	26.	3,200
Submarine	85.3	11.6	....	168	8.	1,200
Dahlgren	147.0	16.4½	4. 7½	146.4	30½	4,200
T. A. M. Craven	147.0	16.4½	4. 7½	146 +	30½	4,200
Farragut (Destroyer)	210.0	20.4½	6. 0	273	30	5,600
Davis	146.0	15.3½	5. 4	128	22½	1,750
Fox	146.0	15.3½	5. 4	128	22½	1.750
Morris	147.0	15.6	4. 6	103	22½	1,750
Talbot	100.0	12.6	3. 6	46½	20.	850
Gwin	100.0	12.6	3. 6	46½	20.	850
Mackenzie	101.6	12.6	4. 3	65	20.	850
McKee	101.6	12.6	4. 3	65	20.	850

IRON AND WOODEN STEAM VESSELS.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I.H.P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
IRON—						
Alarm	158.6	28.0	10.6	800	10.	600
Alert	175.0	32.0	12.9	1,020	10.	365
Monocacy	255.0	35.0	9.0	1,370	11.2	850
Michigan	163.3	27.1½	9.0	685	10.5	305
Pinta	137.0	26.0	10.0	550	8.5	190
Ranger	175.0	32.0	12.9	1,020	10.	365
WOODEN—						
Adams	185.0	35.0	14.3	1,375	9.8	550
Alliance	185.0	35.0	14.3	1,375	9.98	668
Enterprise	185.0	35.0	14.3	1,375	11.4	790
Essex	185.0	35.0	14.3	1,375	10.4	505
Hartford	225.0	44.0	18.2	2,790	12.	2,000
Lancaster	235.8	46.0	19.2	3,250	9.6	733
Marion	216.0	37.0	16.6	1,900	11.25	753
Mohican	216.0	37.0	16.6	1,900	10.65	613
Thetis	166.0	30.3	18.0	1,250	7.55	490
Yantic	180.0	30.0	12.2	900	8.30	225

TORPEDO DESTROYERS RECENTLY CONTRACTED FOR.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
No. 19	231.4	22 0	7.3	340	30.	
No. 20	197.0	20.5	8.6	360	30.	
No. 21	206 9	19.0	8.0	265	30.	

WOODEN SAILING VESSELS.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	No En	gines.
Constellation	176.0	42.0	20.0	1,186		
Jamestown	163.6	36.0	16.0	1,150		
Monongahela	223 0	38.0	16.6	2,100		
Portsmouth	153.0	38.3	16.6	1,125		
Saratoga	147.6	36.1	16.0	1,025		
St. Mary's	150.0	37.6	15.6	1,025		

STEEL, IRON AND WOODEN STEAM TUGS.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I.H.P.
	ft. in	ft. in.	ft. in.	Tons.	Knots	
Fortune	137.0	26.0	9.6	450	10.	340
Guana	92.6	20.11⅜	8.0	192.4	11.5	300
Leyden	137.0	26.0	9.6	450	10.	340
Narkeeta	92.6	20.11⅜	8.0	192.4	11.5	300
Nina	137.0	26.0	8.6	357	11.12	388
Rocket	85.8	18.10	7 0	187	8.5	147
Standish	137.0	26.0	9.6	450	10.	340
Traffic	106.0	29.4	9.0	280	10.	....
Triton	96.9	20.9	9.0	212	13.	300
Unadilla	110.0	25.0	10.0	345	12.	500
Wahneta	92.6	20.11⅜	8.0	192.4	11.5	300
Tugboat No. 5	96.9	21.0	8.9	225	12.0	450

WOODEN STEAM VESSELS UNFIT FOR SEA SERVICE.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Franklin	367.9	54. 3	24.3	5,170	9.	1,050
Iroquois	198.10	33.10	15.3	1,575	10.7	1,202
Minnesota	264.8½	51. 4	23.0	4,700	9.25	1,000
Nipsic	185.0	35. 0	14.3	1,375	10.7	839
Omaha	250.6	38. 0	16.6	2,400	11.3	953
Pensacola	230.8	44. 6	18.7	3,000	9.	680
Richmond	225.0	42. 6	17.4½	2,700	9.5	692
Swatara	216 0	37. 0	16.6	1,900	10.1	680
Wabash	262.7	51. 4	23.0	4,650	9.15	950

WOODEN SAIL VESSELS UNFIT FOR SEA SERVICE.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	No En	gines.
Constitution	175.0	45. 0	20.0	2,200		
Dale	117.7	33.10	14.9	675		
Independence	189.0	51. 6	21.6	3,270		
New Hampshire	196.3	53. 0	25.6	4,150		
St. Louis	126.6	32. 8	15.6	830		
Vermont	196.3	53. 0	25 6	4,150		

If the loss of the gallant crew of the Maine will have the effect of compelling congressional attention to the necessity for a considerable increase of the present fleets, they will not have died in vain. Persons ashore usually fall into the habit of considering the strength of the navy from a peace point of view. The Maine disaster would surely find its counterpart in time of war.

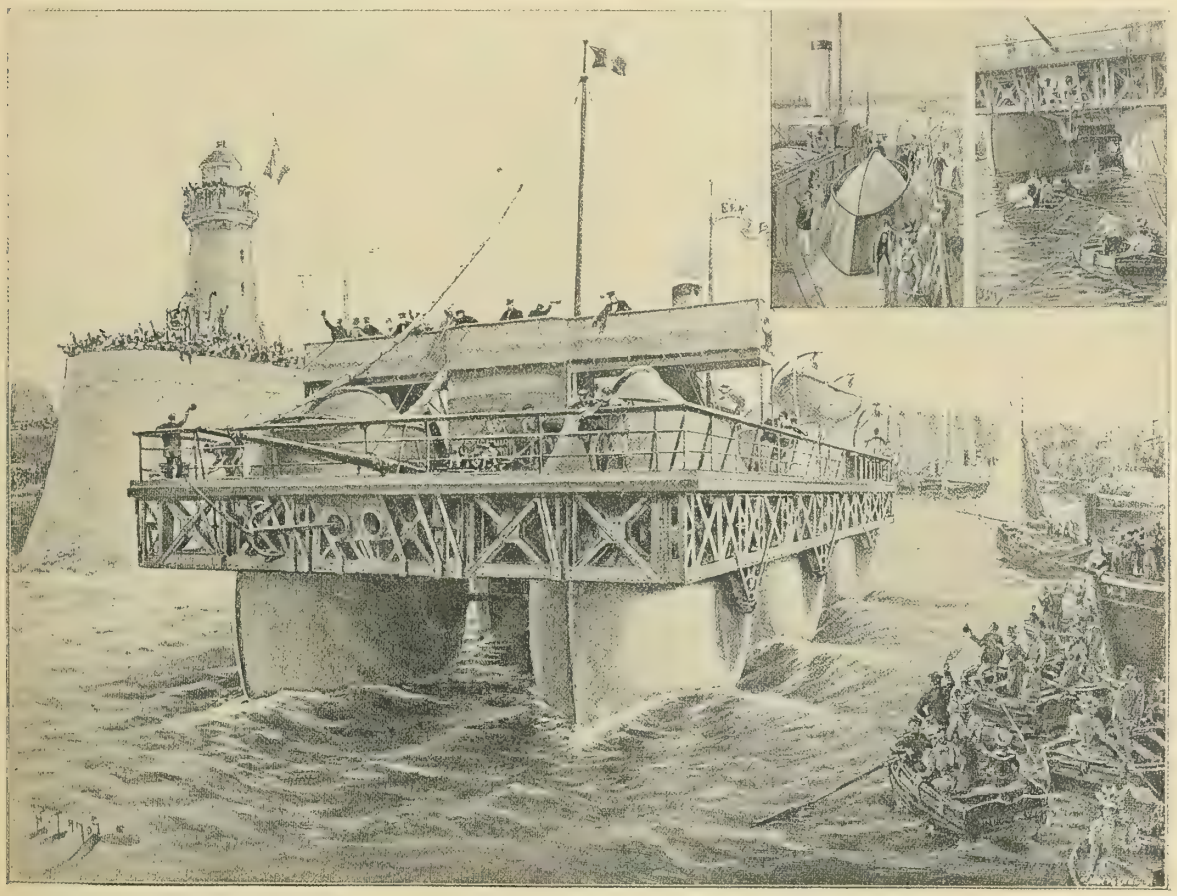
Death of M. Bazin, of "Roller Boat" Fame.

Just as we were going to press last month the death of M. Bazin, the inventor of the now famous "roller boat" was announced. Aside from the personal loss to his family and friends it is much to be regretted that M. Bazin died before he was enabled to carry out his ideas in a large seagoing vessel. The "Ernest Bazin," built after his plans, was considered by experts who had witnessed its performance, as being too small a boat for a proper practical demonstration of his theory.

The "Ernest Bazin" consisted of a rectangular structure mounted on six wheels or rollers arranged vertically along the sides. Each of these rollers had a displacement of about 45 tons and they were connected in pairs athwartships by shafts. By suitable machinery these rollers were caused to revolve slowly, and at the same time a screw of the usual type, immersed in the water, gave an additional propulsive effort. The engines were of 350 I. H. P., arranged to work both the screw and rollers. The special effort of the inventor was to reduce the friction encountered by a vessel passing through the water by causing the immersed portions to have a rolling rather than a rubbing motion. In the trials of the vessel it was found that owing to the number and closeness of the rollers the wave systems created by each came into rapid contact and created such a disturbance of surface conditions that speed was greatly retarded. It was believed by the inventor that with a larger superstructure and fewer wheels this difficulty could be got rid of. As a sea boat the "Ernest Bazin" was said to be rather a success, but as a steam vessel for the transportation of passengers or freight she showed no points of superiority over present designs. It was her experimental value, however, that attracted much serious attention, and among those who studied her operation was Sir Edward Reed, the well-known British naval constructor. In reporting on the result of trials he attended, this distinguished scientist writes:

We began the trials off Havre with very small power and speed. In the first two measured runs only about 112 I.H.P. was exerted by the screw propeller engines, giving, with the rollers at rest, a speed of 4.25 knots. Keeping only the same propelling power at work, but causing the rollers to revolve seven turns a minute by the application of 25.68 I.H.P., we obtained a very remarkable increase of speed, which rose to over 6 knots (more exactly 6.09 knots). I have calculated what the increase of speed would have been had this 25.68 I.H.P. been added to the screw engines instead of being applied to the rollers, and I find that by this means we should merely have added .55 of a knot, thus raising the speed from 4.25 to 4.8 knots only.

In the next experiment the power exerted upon the screw was increased to 295 I.H.P. and the roller power



VIEWS OF THE "ROLLER" STEAMSHIP ERNEST BAZIN, THE INVENTION OF THE LATE M. BAZIN.

to 34.2 I.H.P., the rollers revolving nine turns per minute. I calculate that with the rollers at rest, the increase of horse power upon the screw should have raised the speed from 4.25 to 5.8 knots. The actual speed attained was 6.81 knots, giving an excess of speed due to the revolution of the rollers of 1 knot. It will be seen that this gain is not quite so much as in the previous case, although the power applied to the rollers was somewhat increased—a fact that may be conjecturally accounted for in several ways; but there remains the remarkable fact that the vessel steaming at, say, 5.8 knots, only with 295 I.H.P. applied to her screw, is increased in speed by fully a knot by the application of only 1-9th of that power to her rollers! A further, but small, increase of speed (from 6.81 to 6.97 knots) was obtained by increasing the power on the rollers to 52.2 I.H.P. Small as this increase was, it nevertheless points to the fact that the additional 18 I.H.P. was much more efficient when applied to the rollers than it would have been if applied to the screw propeller.

The views we present herewith are photographic reproductions of views taken for the London Graphic.

An Entire Fleet for "Klondike" Trade.

The most important marine undertaking in connection with the development of the "Klondike" region was begun last month by the organization of the Empire Transportation Co., to operate a line of steamers from Pacific coast ports to Alaska. This is really an extension of the operations of the International Navigation Co. to the Pacific coast. This great American steamship company, as is well known, conducts the Red Star and American Lines in transatlantic freight and passenger trade. The officers of the new Empire Transportation all hold official positions with the International Navigation Co., and they are: President, Clement A. Griscom; Vice-President, W. H. Barnes; Secretary, James J. Hope; Treasurer, James S. Swartz; General Manager, George H. Higbee, and General Agent, Gates D. Fahnestock. The new company commences operations with a fleet of well-known steamers, the Ohio, Indiana, Illinois, Pennsylvania, and Conemaugh. The first four were built by the Cramps several years ago for the old American Line, and when put in service were the finest boats in the transatlantic trade. They are thoroughly staunch vessels, with remarkably good lines, though they do not attain the same speed now as when built. This is because the original powerful and wasteful compound engines were replaced by modern triple expansion engines of less power. After their transfer to the Empire Company the ships were sent to Cramps' yard for a thorough overhauling and refitting to adapt them for the north Pacific trade. When finished they will have accommodation for about 200 first-class and 600 second-class passengers. All the furnishings and equipment will be strictly up to date, including large dining saloons, very comfortable cabins, and electric lighting throughout. The details of heating and ventilation have also received special attention, and a refrigerating plant has been installed on each ship. The fleet will leave Philadelphia some time this month and the first sailing from the Pacific coast will be about June 1.

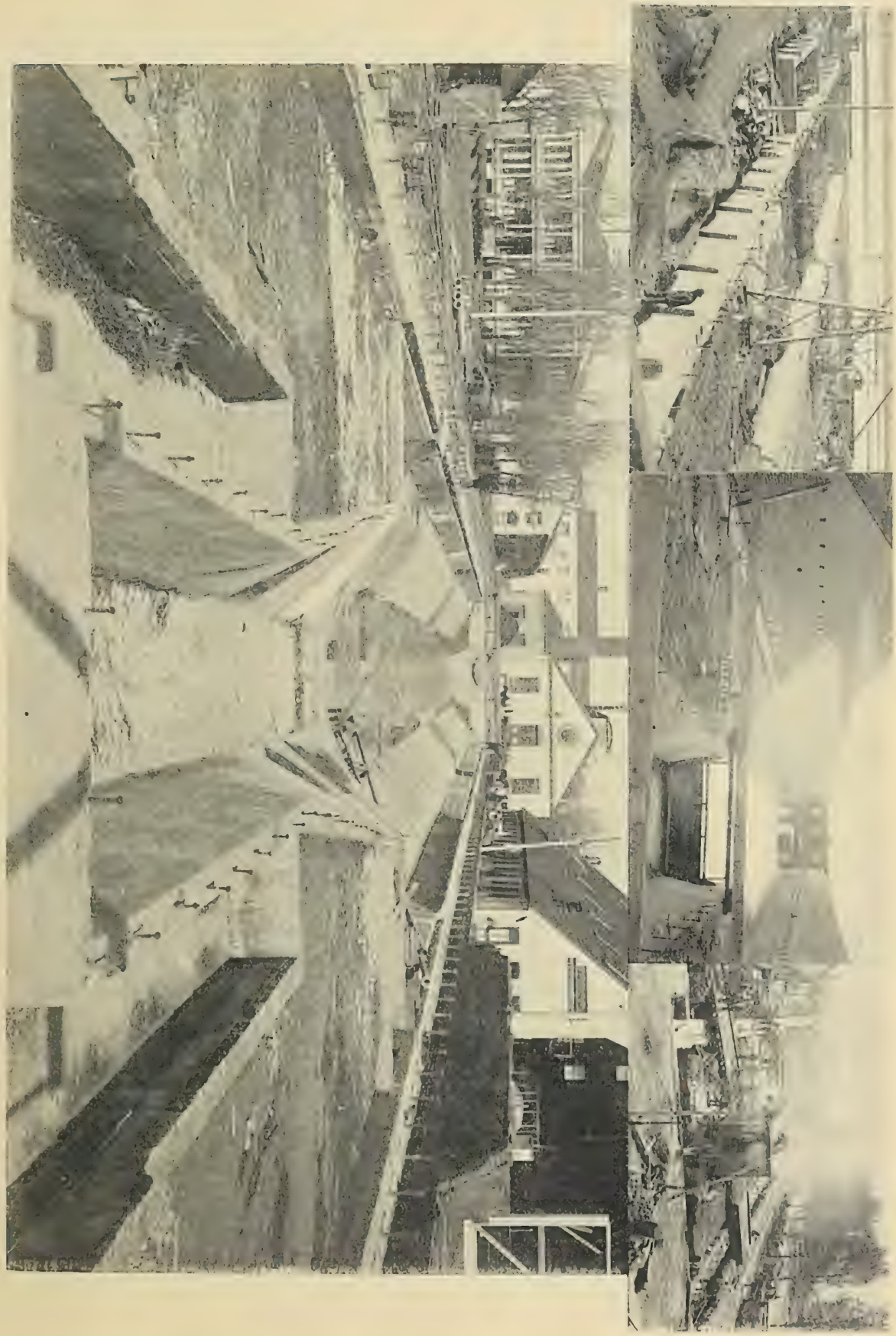
The port of departure on the Pacific coast has not been settled upon, but it is probable that Seattle will be selected, and the northern port St. Michaels. Here the passengers and freight will be transferred to river steamers, which will be operated on the Yukon River, giving direct communication to Dawson City.

Experimental Tank at Washington Navy Yard.

Work on the experimental model tank for the Navy is going forward rapidly at the Navy Yard in Washington. The accompanying photographs, which we are enabled to reproduce through the courtesy of Commodore Hichborn, Chief of the Bureau of Construction and Repairs, show the progress of the work from the original excavations down to the middle of February.

The main building is 500 ft. long, 52 ft. wide, with two extensions, one for office purposes and the other for a pump house. The basin proper is 370 ft. long, 43 ft. wide at the water level, and 14 ft. 9 in. deep from the level of the top of the foundation wall. An inner extension of the foundations will carry the heavy tracks on which the model testing carriage will be run, and the position of these is indicated in the engravings by the rows of holding down bolts. In laying the tracks an absolute nicety of construction will have, of course, to be observed. The carriage has been designed to run at a maximum speed of 33 ft. per second, and this necessitates elaborate provisions for braking and stopping the carriage, without jar, at the end of the course. It will be noticed at each end of the basin there are extensions; that at the south end is 70 ft. long and will be used for balancing and starting the models. The extension at the opposite end is 34 ft. long, and here the apparatus will be installed for stopping the carriage after the completion of each experiment. A uniform length of 20 ft. has been decided upon for the models, the proportion of the model to the represented ship being less or greater as the ship is larger or smaller. Thus a model of a ship 400 ft. long will be one-twentieth of the full size, while that of a 100 ft. torpedo boat will be one-fifth of the full size.

At the present time the brick wall of the building is finished and is ready for the roof trusses. Designs have been completed for the special machinery to be used in towing and recording the performance of the models, and contracts will be let for the construction of this apparatus by the time this appears in print. It has been the aim of the Bureau of Construction and Repair to provide an experimental station which shall in every respect be an improvement over any station abroad. This has necessitated a good deal of original research, but the vast possibilities of the tank will be ample compensation for this labor. At a future time we hope to present some further data concerning this most important undertaking.



VIEWS OF THE U. S. EXPERIMENTAL TANK AT THE WASHINGTON NAVY YARD IN VARIOUS STAGES OF CONSTRUCTION.

HIGH PRESSURES AT SEA WITH SOME CONSIDERATION OF TYPES OF BOILERS.*—I.

BY W. R. CUMMINS.

In commencing, the author referred to a paper read by him in 1890, in which he advocated the use of pressures as high as 250 lb. to the square inch for regular practice, and an increased piston speed over that obtained in the three cylinder, three crank engine as used in the mercantile marine. He suggested then that a four crank, four cylinder engine be designed in which the steam would be used expansively in each cylinder. At the same time he called attention to the unsuitability of the cylindrical return-tube boiler for high pressures, and also suggested a modification in design. Since the date referred to, the use of four cranks had grown in favor, the author stated, but the boiler of 150 lb. to 180 lb. pressure had remained the same as six years before. Meanwhile, however, the water tube boiler had been introduced in various forms, and in many cases had been accompanied by an increase of working pressure. The author said he believed there was only one case of cylindrical return tube boilers working at a pressure higher than 250 lb.; that of the S. S. Inchmona. On this vessel the working pressure is 225 lb. per sq. in. In the present paper the author declared he would first recapitulate the arguments of the former paper as to the economy to be expected from an increase of pressure, and would touch upon the commercial phases of the question; then he would consider the type of boiler best suited to the new conditions; and lastly, would make some suggestions as to the proper design of engine. Having thus outlined his plan of discussion, he continued:

The coal economy effected by substituting the triple-expansion engine with boilers working at 150 lb. pressure for the compound engine with boilers working at 80 lb. is, generally speaking, about 25 per cent. Let it be assumed that in the case of the compound the mean pressure referred to the low-pressure cylinder would be 21 1-2 lb. The total number of expansions requisite to obtain this mean pressure would be 6 3-4. For the sake of simplicity the term "expansions" in this paper will mean the valve expansions—that is to say, the ratio of expansion—neglecting the effect of clearance space, etc., on that ratio. Then, if an economy of 25 per cent is obtained by using a boiler pressure of 150 lb., the mean pressure referred to the low-pressure cylinder of the triple expansion engine will be 21 1-2 plus 25 per cent—say 26 1-2 lb. The total expansions necessary to obtain this mean pressure will be 11 3-4. Thus we have in the case of the compound 95 lb. absolute pressure in the boiler, 6 3-4 expansions, and 21 1-2 lb. mean pressure referred to the low-pressure cylinder; and in the triple expansion engine 165 lb. absolute pressure in the boiler, 11 3-4 expansions, and 26 1-2 lb. mean pressure referred to the low-pressure cylinder. These, it may be stated, are average voyage figures, with the compound using about 2 1-4 lb. coal per indicated horse power per hour, and the triple about 1 5-8 lb. per indicated horse power per hour.

We have next to determine the theoretical economy of steam of 165 lb. absolute pressure over steam of 95 lb. absolute pressure, under the above conditions.

In the first place, Carnot's formula,

$$\frac{T_1 - T_2}{T_1} = \text{efficiency},$$

will not apply to this case, as it does not take into account all the facts regarding the working of steam.

Thus, for steam of 95 lb. absolute pressure,

T_1 (= absolute temperature at which heat is received) = 785 deg. Fah.

T_2 (= absolute temperature at which heat is rejected) = say 80 deg. Fah. + 461.2 deg. Fah. = 541 deg. Fah.

For steam of 95 lb. pressure,

$$\frac{785 - 541}{785} = .310 \text{ efficiency}$$

For steam of 165 lb. pressure,

$T_1 = 827$ deg. Fah.;

$$\frac{827 - 541}{827} = .345 \text{ efficiency};$$

$$\frac{.345 - .31}{.310} \times 100 = 11 \text{ per cent}$$

economy of steam; of 165 lb. absolute pressure over steam of 95 lb. absolute pressure, according to Carnot's formula.

As will be shown further on, the actual theoretical economy is considerably more than this figure. It is probably owing to the misapplication of this formula that the triple-expansion engine has had the credit of its economy put down to the fact of it expanding the steam in three stages instead of two, as in the compound; the argument being that the initial condensation is diminished owing to a lessened range of temperature in each cylinder.

It is well known that when dry saturated steam expands adiabatically doing external work, that a portion of the steam is liquefied, and to calculate the amount of this external work we must know how much of the steam is liquefied during expansion. Professor Rankine gives the following formula for the proportion of steam liquefied during expansion:

$$\text{Proportion} = 1 - \frac{T_2}{L_2}\left(J \log_e \frac{T_1}{T_2} + \frac{L_1}{T_1}\right),$$

where T_1 = absolute temperature at beginning of expansion in deg. Fah;
T_2 = absolute temperature at end of expansion in deg. Fah;
L_1 = latent heat in foot-pounds per lb. of steam at beginning of expansion;
L_2 = latent heat in foot-pounds per lb. of steam at end of expansion.

Rankine's formula does not give the liquefaction for any definite number of expansions;

* From a paper read at the North-East Coast Institute of Engineers and Shipbuilders in Sunderland, England.

hence the temperature at end of expansion must be determined by trial and error to suit the given expansions. This has been done in the following calculations:

For steam of 95 lb. absolute pressure, 6 3-4 adiabatic expansions, and terminal pressure 11 lb. absolute,

$T_1 = 785.084$ deg. Fah,
$T_2 = 658.968$ deg. Fah,
$L_1 = 683,674$ foot-pounds,
$L_2 = 753,288$ foot-pounds,

and the proportion of steam liquefied at end of expansion = 12.21 per cent.

Thus we have at the beginning of expansion 1 lb. of steam at 95 lb. absolute pressure, and at the end of expansion .8779 lb. steam at 11 lb. pressure and .1221 lb. water.

V_1 = volume of 1 lb. steam at 95 lb. absolute pressure = 4.494 cu. ft.
V_2 = volume of .8779 lb. steam at 11 lb. absolute pressure + volume of .1221 lb. water = 30.379 cu. ft.

$$\text{Ratio of expansion} = \frac{V_2}{V_1} = 6.76.$$

Then, assuming that the above proportions of steam and water do not vary during the exhaust period, and that the back pressure = 4 lb. absolute, we have

Heat received = total heat of 1 lb. steam at 95 lb. absolute pressure = 1212.729 thermal units. Heat rejected = total heat of .8779 lb. steam at 4 lb. absolute pressure = 1018.912 + heat of .1221 lb. water at the corresponding temperature = 18.729 thermal units. Heat utilized = heat received — heat rejected = 1212.724 — (1018.912 + 18.729) = 175.082 thermal units.

For steam of 165 lb. absolute pressure, 11 3-4 expansions, and terminal pressure 10 lb.,

$T_1 = 826.944$ deg. Fah.,
$T_2 = 654.440$ deg. Fah.,
$L_1 = 660,110$ foot-pounds,
$L_2 = 755,755$ foot pounds,

and the proportion of steam liquefied at end of expansion = 15.24 per cent.

Starting with the same quantity of heat as in the previous case, we have

$$1 \times \frac{1212.724}{1225.493} = .9895 \text{ lb.}$$

steam at beginning of expansion at 165 lb. pressure, and at the end of expansion .8387 lb. steam at 10 lb. pressure and .1508 lb. water.

V_1 = volume of .9895 lb. steam at 165 lb. pressure = 2.737 cu. ft.
V_2 = volume of .8387 lb. steam at 10 lb. pressure + volume of .1508 lb. water = 31.769 cu. ft.

$$\text{Ratio of Expansion} = \frac{V_1}{V_2} = 11.68$$

Let the back pressure be 4 lb. absolute, as before, and we have

Heat received = total heat of .9895 lb. steam at 165 lb. pressure = 1212.724 thermal units. Heat rejected = total heat of .8387 lb. steam at 4 lb. pressure = 973 416 thermal units + heat of .1508 lb. water at corresponding temperature = 23.132 thermal units. Heat utilized = 1212.724 — (973.416 + 23.132) = 216.176 thermal units.

Then,

$$\frac{216.176 - 175.082}{175.082} \times 100 = 23.47 \text{ per cent}$$

economy of steam of 150 lb. boiler pressure over steam of 80 lb. boiler pressure.

To show that this economy is not due to mere expansions, take the case of steam of 95 lb. absolute pressure expanded the same number of times as the steam of 165 lb. absolute pressure, viz., 11 3-4 times; the terminal pressure in this case will be 6 lb., and

$T_1 = 785.084$ deg. Fah.,
$T_2 = 631.323$ deg. Fah.,
$L_1 = 683,674$ foot-pounds,
$L_2 = 768,332$ foot-pounds.

The proportion of steam liquefied at end of expansion = 13.71 per cent. Thus we have at beginning of expansion 1 lb. of steam at 95 lb. absolute, and at end of expansion .8629 lb. steam at 6 lb. absolute, and .1371 lb. water.

V_1 = volume of 1 lb. steam at 95 lb. absolute = 4.494 cu. ft.
V_2 = volume of .8629 lb. steam at 6 lb. absolute + volume of .1371 lb. water = 52.939 cu. ft.

$$\text{Ratio of expansion} = \frac{V_2}{V_1} = 11.77.$$

Heat received = total heat of 1 lb. steam at 95 lb. absolute = 1212.724 thermal units. Heat rejected = total heat of .8629 lb. steam at 4 lb. absolute = 1001.503 thermal units + heat of .1371 lb. water at corresponding temperature = 21.030 thermal units. Heat utilized = 1212.724 — (1001.503 + 21.030) — 190.200 thermal units.

$$\frac{216.176 - 190.200}{190.200} \times 100 = 13.65 \text{ per cent}$$

economy of steam of 150 lb. boiler pressure expanded 11 3-4 times over steam of 80 lb. boiler pressure expanded 11 3-4 times.

It is thus seen that the mere fact of raising the boiler pressure from 80 lb. to 150 lb., and expanding the same number of times, causes an economy of about 13 1-2 per cent.

The lessons to be learnt from this fact are: first, that "thermal units should be used while they are hot"—that is to say, every opportunity should be taken, when designing cylinders, steam ports, and passages, to prevent steam of higher pressure giving up its heat to steam of lower pressure; and, secondly, that unless we can obtain direct proof to the contrary, there is no appreciable coal economy in expanding steam in several stages.

For steam of 220 lb. absolute pressure, 15 3-4 expansions, 30 lb. mean pressure, referred to the low-pressure cylinder, and theoretical terminal pressure 9 lb.,

$T_1 = 851.04$ deg. Fah.,
$T_2 = 649.516$ deg. Fah.,
$L_1 = 646,422$ foot-pounds,
$L_2 = 758,439$ foot-pounds,

and the proportion of steam liquefied at end of expansion = 17.10 per cent.

Thus we have at the beginning of expansion .9836 lb. steam at 220 lb. absolute pressure, and at the end of expansion .8154 lb. steam at 9 lb. absolute pressure, and .1682 lb. water.

V_1 = volume of .9836 lb. steam at 220 lb. = 2.41 cu. ft.
V_2 = .8154 lb. steam at 9 lb. absolute pressure + volume of .1682 lb. water = 34.112 cu. ft.

$$\text{Ratio of expansion} = \frac{V_2}{V_1} = 15.80.$$

Heat received = total heat of .0836 lb. steam at 220 lb. absolute pressure = 1212.724 thermal units. Heat rejected = total heat of .8154 lb. steam at 4 lb. pressure = 946.373 thermal units + heat of .1682 lb. water at corresponding temperature = 25.801 thermal units. Heat utilized = 212.724 — (946.373 + 25.801) = 240.550 thermal units.

$$\frac{240.550 - 216.176}{216.176} \times 100 = 11.27 \text{ per cent}$$

economy of steam of 205 lb. boiler pressure over steam of 150 lb. boiler pressure.

For steam of 265 lb. and 26 1-2 + 18 per cent, say = 31 1-2 lb., mean pressure referred to low-pressure cylinder, the number of expansions will be 18 1-2, and the terminal pressure 9 lb. absolute.

T_1 = 867.040 deg. Fah.,
T_2 = 649.516 deg. Fah.,
L_1 = 637,186 foot-pounds,
L_2 = 758,439 foot-pounds,

and the proportion of steam liquefied at end of expansion = 18.16 per cent.

Thus we have at the beginning of expansion,

$$1 \times \frac{\text{total heat of steam at 95 lb.}}{\text{total heat of steam at 265 lb.}} = .9798 \text{ lb.}$$

steam at 265 lb. absolute pressure, and at the end of expansion .8019 lb. steam at 9 lb. absolute pressure and .1779 lb. water.

V_1 = volume of .9798 lb. steam at 265 lb. pressure = 1.833 cu. ft.
V_2 = volume of .8019 lb. steam at 9 lb. absolute pressure + volume of .1779 lb. water = 33 592 cu. ft.

$$\text{Ratio of expansion} = \frac{V_2}{V_1} = 18\ 32.$$

Heat received = total heat of .9798 lb steam at 265 lb. absolute pressure = 1212.724 thermal units. Heat rejected = total heat of .8019 steam at 4 lb. absolute pressure = 930.705 thermal units + heat of .1779 lb. water at corresponding temperature = 27.289 thermal units. Heat utilized = 1212.724 — (930.705 +27.289) = 254.730 thermal units.

$$\frac{254.730 - 216\ 170}{216.170} = 18 \text{ per cent.}$$

economy of steam of 250 lb. boiler pressure over steam of 150 lb. boiler pressure.

The following table shows the relative economy of the different pressures and expansions:

Pressure	80	80	150	205	250
Mean pressure on low pressure cylinder	21½		26½	30	31½
Expansions	6¾	11¾	11¾	15¾	18½
Relative economy	100	108	123	137	145

By this it appears that, by putting up the boiler pressure to 205 lbs., a saving in coal consumption could be expected, and by a further increase of pressure to 250 lbs., a saving of 18 per cent would result. This suggested the question: Would it pay the shipowner to attempt this increase of pressure and consequent saving in coal consumption? In the first place, a substantial gain would have to be assured to compensate for the extra care and attention required for higher pressures. It would thus be necessary, if an increase of pressure was attempted, that it should not be less than 250 lbs., thus gaining the economy of 18 per cent.

For purpose of comparison, continued the author, take a boat 310 ft. by 40 ft. by 21 ft., carrying 3,500 tons deadweight and 4,000 tons measurement on 19 ft. 6 in. draught, fitted with triple expansion engines, 23 in., 35 in., and 60 in. by 42 in., running at 65 revolutions per minute, and indicating about 1,000 indicated horse power, with 26 1-2 lbs. mean pressure referred to the low pressure cylinder. The coal consumption at 16 lbs. per indicated horse power per hour would be 17.14 tons per day, which, with a bunker capacity of 540 tons, gives 31 days' steaming. Supposing that engines and boilers working at 250 lbs. pressure and indicating the same power as the triple were substituted, and that they occupied the same space, and cost the same money as the triple, the shipowner would effect savings: First, in the cost of bunker coals; second, in the smaller bunker capacity required, and consequently more space available for cargo, or with the same bunker capacity the ability to steam longer without coaling. With engines working at 250 lbs. boiler pressure and an estimated economy of 18 per cent, the consumption would be reduced to 14 tons per day. The number of steaming days will average about 190 in the year, and a saving on the bunkers at, say $2 per ton, would be:

$$2 \times 190 \times 3 = \$1,140 \text{ per annum.}$$

The bunker capacity can be reduced 18 per cent and turned into cargo space. The space thus saved would be 4,170 cu. ft. = say, 104 tons of cargo at, say, $12 per ton per annum = $1,250. This added to $1,140 saved on bunkers = $2,390 total saved per annum. The total expenses of such a steamer, less bunkers, would be about $36,500 per annum.

Hence, total expenses with triple expansion engines = $43,01
Total expenses, with engines and boilers working at 250 lbs. pressure ..... = 40,320
Saving to shipowners:

$$\frac{43,010 - 40,320}{43,010} \times 100 = 6.25 \text{ per cent of total expenses.}$$

This estimate is based on the assumption that the machinery working at a higher pressure costs the same and occupies the same space as the triple expansion machinery, also that the cost of repairs, engine room stores, and wages are the same in both cases. Suppose, however, that the higher pressure machinery cost $7,500 more than the triple expansion machinery still occupying the same space, then the above saving will be reduced by the interest on $7,500 at say, 8 per cent = $600, and the saving to the shipowner will be only $43,010—$40,920 = $2,090 = 5 per cent of total expenses. Or, suppose that the higher pressure machinery occupies a frame space more than the triple engines, but costs the same money, then the above saving will be reduced by the value of one frame space = 1,776 cu. ft. = 45 tons cargo at say, $12 per ton per annum = $540, and the saving to the shipowner will be only $43,010—$40,860 = $2,150 = 5 per cent on total expenses. If the machinery were to cost $7,500 more, and occupy one frame space more, the saving would be only $43,010—$41,460 = $1,550 = 3.5 per cent of total expenses. From this it will be seen that if the higher pressure is to be adopted it is very essential that the new machinery should not cost any more, nor occupy any more space, than the triple expansion machinery.

We can now pass on to consider the boiler question. The first question which arises is, How will the new conditions affect the transmission of the heat through the heating surface?

From Peclet's experiments and deductions it would appear that the quantity of heat transmitted through a plate varied as (1) the surface exposed, (2) as the difference of temperature of the plate on the fire side and on the water side, and (3) inversely as the thickness of the plate; or

$$M = (t_1 - t_2)\ \frac{C}{E}$$

where M = thermal units transmitted,
t_1 = temperature of plate on fire side,
t_2 = temperature of plate on water side,
C = constant depending on material and state of surface,
E = thickness of plate.

Peclet's experiments, however, were carried out by steam heat only, and are thus not applicable to the case of fire heat.

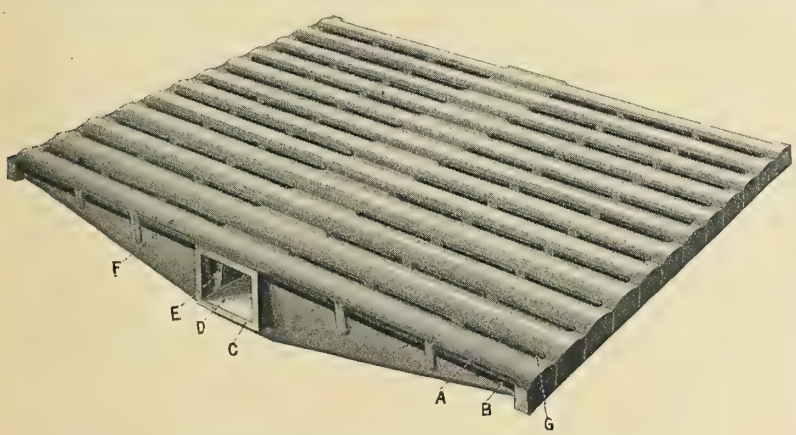
IMPROVED APPARATUS.

Gadey Hollow Cast Iron Grate Bar.

An improved form of hollow cast iron grate bar is shown in the illustrations of the Gadey air grate. This is composed of bars 2 3-4 in. wide, so constructed that when they are placed together to form a grate a uniform supply of air can be blown

SECTION OF GADEY GRATE BARS.

into them and delivered from the interior of the bars, through slots, to the surface of the grate. The air flowing out at the surface of the grate has the effect of syphoning the natural draft between the bars, as well as of itself supplying an increased and well distributed supply of oxygen. In the lettered engraving of the grate A indicates the overhanging edge which prevents ashes from dropping into the slot. B shows the narrow slots

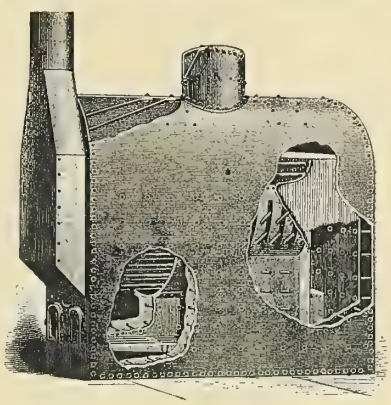


GADEY HOLLOW CAST IRON GRATE.

which act as air-outlets. The faced surface, which forms a joint between the bars, is shown by C and D, and is the supply chamber which is connected with the blower, and carries the air supply transversely across the grate when set in the boiler. The air chamber in each separate bar is indicated by E. The letter F shows the curved top of the bar and G the opening between the bars for natural draft. In the cross section air chamber E is shown more plainly. The blast pipe is connected to a faced joint below the supply chamber D at one side of the grate. In the sectional view the rib on the under side of the top of the bars will be noticed. This not only strengthens the bar but aids in distributing the outflow of air evenly on both sides of the bar. The grate is manufactured by Brown Bros. Mfg. Co., of Chicago, and is marketed by E. P. Gould, 57 East Kinzie St., Chicago, the agent for the United States.

DePuy Double-Firebox Leg Boiler.

A new type of leg boiler is shown in the illustration of the Paragon boiler, just patented by Captain M. DePuy. It is a double-firebox re-



DEPUY LEG BOILER.

turn tubular boiler with center and side legs extending from the water end in front to the water end in the back, thus forming a continuous water leg all around the boiler. Socket bolts stay the fireboxes and shell. These side and center legs, in addition to being open at both ends, are provided with slot openings through the shell, spaced 5 in. apart, which provide for a free circulation of water throughout the entire boiler. The spaces between the center and side water legs are used as fire boxes, there being at the rear a flue box across the flue sheet from which extend horizontal flue tubes terminating at the front header. More space is provided between the tubes directly over the central water leg, thus promoting the free circulation of water over and through this leg; the ends of the side and center water legs being open, the several legs practically form one continuous water leg. The address of Captain M. DePuy, inventor, patentee, is 19 South St., New York.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.
S. W. ANNESS, Philadelphia, Pa., Bourse Building.

Western Representatives.
L. L. CLINE, Detroit, Mich., 47 Hodges Building
B. M. GARDNER, 1142 Monadnock Block, Chicago, Ill

Traveling Representatives.
E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

DURING the preparation of this issue for the press it became our sad task to chronicle the loss of the second-class battleship Maine, in Havana Harbor, with two officers and a majority of her crew. The horror of the mishap, which without warning or preparation slaughtered more than 250 gallant seamen, was deepened by the sinister rumors which soon spread abroad as to its probable origin. That there was an explosion the results only too horribly proved, but whether by accident or intent was not apparent. Interest in the subject from the point of view of the trained technical mind became intense, and but little satisfaction was to be obtained from a perusal of the inaccurate, if not misleading and absurd reports, bearing on this aspect, in the press of the country. It has thus become for us a duty to present such technical information as would make possible an accurate knowledge of the construction and equipment of the vessel. This is accompanied by authentic engravings illustrative of the warship and her machinery equipment and also by accurate sections drawn to scale. This scale has been made so that only an ordinary two-foot rule is necessary to obtain a clear conception, in dimensions, of the interior arrangement of the "Maine." The amount of space which we have thus devoted to placing facts concerning the disaster before our readers, has compelled the holding over of much other important, technical matter until a future issue.

AS an exhibition of self-restraint and fair play, the attitude of the Executive and Legislative branches of the Government, since the terrible disaster at Havana, has compelled admiration the world over. This calmness is indeed more terrible, and full of portent, than the blusterings and boastings, which many public prints would have the superficial student of affairs believe was the voice of the nation. But it is not of things political that we desire to speak. The appointment of a Board of Inquiry to examine into the causes of the disaster, and the despatch of well equipped wrecking outfit to the scene, showed a desire to promptly discover what agency was responsible for the loss of life and public property. But unfortunately the voice of the courtier was heard amid the silence of wisdom, and a Board of Inquiry was appointed consisting of Captain W. T. Sampson, Captain F. E. Chadwick, Lieutenant-Commander W. P. Potter and Lieutenant-Commander Adolph Marix—line officers to a man. There is no doubt of the character and standing of these gentlemen, whose honorable records and present commands show that they are morally the equals of any. But this inquiry is not to decide whether an ensign properly paid court to the daughter of a civilian; it is an inquiry into the causes of a disaster of a purely mechanical nature. It calls for that most accurate technical knowledge which only special training and long experience can supply. Looking at the composition of the board two members are manifestly well equipped for their duties. Captain Sampson in his connection with the Bureau of Ordnance had rare opportunities for a familiar knowledge of explosives, and Captain Chadwick in the Bureau of Equipment doubtless became expert in his knowledge of coals, and their properties, and of many other more or less dangerous stores. So far the selections were wisely made. But why this discrimination against the great Naval Departments of Construction and Engineering? Structural questions are of vital importance in this investigation, yet not a man on the board would be intrusted by any sane shipbuilder with the construction of even a river tug. Are there no honorable, splendidly trained men among the Chief Constructors of our Navy? men who had drawn or supervised the plans of the Maine. Again, why is not the engineering branch represented? From the Spaniards themselves comes the assertion that a boiler exploded, and yet not an officer on the

board could lay claim to expert knowledge of the construction or operation of the marine boiler. Are there no names on the list of Chief Engineers that stand for sterling merit and knowledge, and as true American courage as that of any man who ever walked the quarter deck? In an examination of the kind undertaken by the Board of Inquiry exact conclusions are not reached by the evidence of any one man. It is the little facts, out of many mouths, that, articulated like the bones of some fossil animal, disclose the living truth. Each scientist on such a board is alive to every utterance which may find response in his special knowledge. The minute fact that the mere disciplinarian would unknowingly pass over, is, to the specially trained, the possible key to the whole situation. The reasons for the selection of the Board of Inquiry may be according to the book of naval etiquette, but are not to be found in the primer of common sense.

THE conservatism of the technical press has been in sharp contrast to the garrulity and inaccuracy of the daily press, with few exceptions. We regret to note, however, the countenance lent by the esteemed Scientific American to wilful misstatement and pictorial misrepresentation as displayed in its issue of February 26. In this issue of our contemporary a "longitudinal section through battleship Maine" is given, which originally appeared in one of the New York daily papers, which paper has persistently sought (at this time) on no basis of fact to prove the criminal responsibility of Spain. In this "section" a "torpedo room" is shown on the platform deck forward of the fore magazine, and underneath a compartment containing what are presumably explosive heads for torpedoes. In reality these compartments were filled with provisions and stores, and the only torpedo heads aboard were stowed in a magazine in the hold abaft the engines. Again instead of the score or so of torpedo heads shown in this "section" there were actually eight heads on board. Each of these was filled with guncotton, to be sure, but this was kept wet—perfectly safe to handle. In fact a seaman with an axe could have chopped the contents of any of these heads in pieces without danger to himself or surroundings. For the information of our contemporary we might add that the Whitehead torpedo, minus the head, is no more harmful than the captain's gig, and not half so cumbrous. Torpedoes are simply small vessels for carrying explosives, modeled on the lines of a fish, so as to offer the least possible resistance when traveling at high speed through the water. They are carried usually in racks close to the torpedo tubes, which in the case of the Maine had broadside discharge on the berth deck. In peace times the torpedo is fitted with a practice head weighted with water to correspond to the weight of the guncotton in the war head. The wet guncotton in this head cannot be discharged except by the use of a small portion of dry cotton and a detonating fuse. Spain has surely enough innocent blood on her hands, without the striving of rival publications to add that of the victims of the Maine disaster, unless proper proof is presented.

THE loss of the Holland-American liner Veendam at sea and the rescue of her passengers and crew by the American liner St. Louis, was the ground work of a tale of heroism as stirring as any the pages of fiction hold. The quiet bravery of the officers of the sinking vessel, in adopting all possible means of saving their ship, and then their passengers, is a fine setting for the splendid seamanship and courage of the rescuing crew. The Old World and the New can both be proud of the humanity of their sons and shake hands across the sea. There is one feature of the mishap, which reiterates an important lesson; the necessity for placing the electric generating plant high enough up in the vessel to prevent the extinction of the lights in case of serious structural damage. In the Veendam this appears to have been the case, for the electric lights were glowing up to the time the vessel was abandoned. When the stoke holds were flooded the donkey boiler furnished the necessary steam to keep the engines and generators running. What would have occurred had the lights throughout the ship been extinguished by the flooding of the engine room is not pleasant thinking. In many vessels, including some of the newest and best equipped, the electric plant is away below, in a corner of the engine room, or in the recess between the thrust blocks, and any rupture of the skin in this vicinity would speedily leave the ship in darkness. The value of having the dynamos well above water was lately illustrated in the wreck of the British transport, Warren Hastings, the engineers keeping the generators going until everyone else had got away.

Discussion on the Parsons' Steam Turbine as Applied to Marine Propulsion.

At a recent meeting of the Institute of Marine Engineers, in London, there was a discussion upon the paper, "The Progress of the Steam Turbine" by Hon. Charles Parsons, which was published in our issue of December last. The Chairman, MacFarlane Gray in opening briefly referred to the principal features of the turbine engine described in the paper, and stated that Mr. Parsons was unable to be present at the meeting, but would be represented by Mr. Martin, who would be prepared to answer any question on the subject. The discussion as reported by the Engineers' Gazette, London, is of much interest.

Mr. Froom inquired the object of Mr. Parsons in having two or three propellers on the one shaft.

Mr. Martin, in reply, said that the original difficulty in using only one screw arose from the cavitation of the water, although probably that was not the only reason why three propellers were subsequently used. A considerable advantage resulted from dividing up the turbine and using two or three shafts with three screws on each. The division also led to a considerable advantage in steam consumption.

The Chairman said he might supplement the answer just given. The gentleman who put the question doubtless supposed that the second propeller on the shaft would simply be working in the water that had been previously set in motion by the first propeller; but the explanation was that the propellers were very small, and this smallness of dimensions exaggerated the distance between the screws. Each propeller acted upon comparatively new water, and in that way the motion created by the first propeller had practically no detracting effect upon the water which was operated upon by the second and third propellers.

Mr. Froom raised a further question as to the action of the steam turbine being due to the impact or reaction of the steam.

The Chairman said he had often explained to members of the institute how pressure and impact were the same thing, and how when steam acted upon a piston, what was called pressure was really impact and reaction. He asked them to take the case of a solitary molecule of steam acting upon an ordinary piston. Let them suppose that this molecule of steam was traveling in the cylinder at the rate of 1,000 ft. per second, while the piston was traveling 1 ft. per second in the same direction. It eventually struck the piston, and the velocity of the impact was 999 ft. per second, as the piston was moving and its velocity had to be deducted to get the velocity of impact. Then the steam molecule rebounded from the piston, and what, he asked, was the velocity of the rebound? The velocity of the rebound was always the velocity of the impact, and, therefore, the velocity of the rebound was 999 ft. per second. But this was rebound from a piston moving one ft. per second, or 998 ft. velocity in relation to the stationary cylinder. It had lost velocity to the extent of 2 ft. per second, and it had lost that velocity in the impact and rebound. Every time that a molecule of steam struck the piston it lost velocity equal to twice the velocity of the piston. In Parsons' engine the velocity of the steam was diminished by twice the velocity of the blade that it struck. The steam lost nothing by striking the stationary blades; it was only the moving blades that it did work upon. The loss of velocity was transfer of energy. In every cubic inch of steam there were more than a million molecules, and each one hit millions of time each second. This velocity was the molecular velocity of steam. The velocity through the turbine was molar or steam velocity, which was the source of power in the water turbine but not in the steam turbine, on the whole. Throughout the action of the steam there was a continuous expansion going on creating steam velocity, which was immediately lost again in impact and made up again in the next expansion when passing the stationary deflecting blades. In the tortuous steam canals formed by the deflectors they had steam expansion in its best form, free from initial condensation along with the impact action or reaction of the hydraulic turbine.

Mr. Ruthven said there were two points upon which he should like further information. First, he would like to know the quantity of water that was evaporated by the boilers at any given speed; and, secondly, the force that was on the thrust at the time—the propulsive force.

Mr. Martin said he did not know that he could give the information just asked for off-hand, but would furnish it subsequently if possible.

In reply to further questions the Chairman said that the diameter of each propeller was 18 in. He could not give the pitch. According to the speed of the vessel the pitch must have been between 2 ft. and 2 ft. 6 in.

Asked the object of having three propellers in line.

The Chairman said that if the three times three propellers were not put three in a line they would require nine shafts instead of only three. Mr. Parsons at first thought that a difference in pitch would be better, and he made them so. He was in doubt, and he asked nature by experiment to tell him which he should use. The answer he obtained was that the practical benefit of variation was so small that it could not be measured, but he could very easily measure the advantage of having the nine propellers all the same, and he, therefore, made them all alike.

Mr. Ruthven said it would be interesting to many members to know how the little curved blades in the steam turbine were made.

Mr. Martin replied that at present these blades were wire drawn. They were fitted with a square base and keyed into the shaft and calked. The fitting of the blades into the shaft was not at all a difficult operation. They could be put in very quickly.

Mr. Smith said it would be interesting if they could be informed what would be gain or loss if, instead of allowing the steam to go below the atmosphere, Mr. Parsons made the final above the atmosphere. Could he possibly get the latent heat back again in the boiler, and, if so, what would be the gain or loss by it?

The Chairman said it would take a long time to answer Mr. Smith's question. It had been the dream of a great many would-be inventors to put the latent heat back again. These men imagined that the steam engine was handicapped by the latent heat of water being so great. The Merchant engine and other follies had, therefore, been put before the public. When a better knowledge of steam was obtained it was found that the greatness of the amount of the latent heat of water was the secret of the greatness of the economy of steam power.

Mr. Ruthven asked what value Mr. Parsons got out of the coal by using his engine—whether more or less than in an ordinary engine?

The Chairman: "He claims it to be as economical as the most economical engine, and the results obtained by the careful experimental tests made by Professor Ewing, the great authority on steam, corroborate this claim."

Mr. Swift said he should very much like to get the pitch of the blades on the Turbinia's propellers. By the water-turbine they could get certain positive data from the angles of the blades, pressure, etc., and by working through the turbine they might get to know something by using the expansive properties of steam, but until they got an indicator diagram of this engine how could they tell what horse power was obtained per pound of coal? That was a point which Mr. Parsons was working out, and he thought it might be left with him for the present. But there was another practical point. The weight of this motor in the Turbinia was said to be three tons, but this appeared to

be only half the engine. Mr. Parsons said that he proposed to fit another turbine to take the boat astern at the rate of 10 knots an hour. But what was 10 knots an hour astern with a boat going 34 knots an hour ahead? In his experience they could never get a ship astern fast enough to please the people on the bridge, and to get the same result astern as ahead they would have to double the plant. There could be no mistake that the thing was coming. The turbine would be the thing of the future, but they must not jump to the conclusion that the motor which had been shown them was a complete and pertect engine. He should like to hear the views of other gentlemen present as to whether in a boat going 34 knots an hour ahead a power to go only 10 knots an hour astern was sufficient?

Mr. Martin said he believed that the power to go astern at 10 knots was in accordance with usual requirements. Could any steamer go astern as fast as she went ahead?

Mr. Swift: "But in the present steamers you have the full power of the engines whilst reversing."

Mr. Martin said he thought that for all practical purposes the power to go astern at 10 knots was sufficient. It was very easy to get at the efficiency of the turbine engine when it was connected to an

Mr. MacLarran asked if Mr. Parsons made any provision for holding the weight of the go-ahead screws when the vessel was going astern.

The Chairman, in reply, said it was not necessary to make any provision for holding the screws, because when the vessel was going astern the other screws would simply revolve with the water and cause the turbine to revolve. Mr. Swift had raised a very interesting question, but his (Mr. Gray's) view was that the power to go astern at 10 knots was quite sufficient. It must be remembered that Mr. Parsons could start his engine full speed astern at once.

MISHAPS AT SEA.

Loss of the Holland-American Liner Veendam.

The Holland-American line steamship Veendam, bound west from Rotterdam for New York, with passengers and cargo, was abandoned at sea early on the morning of February 7, in a sinking condition. The passengers and crew were taken off by the American Line steamship St. Louis, bound for New York, which was following the same transatlantic course. No lives were lost, and the St. Louis arrived in New York about her regular time, having lost only four hours in the work of rescue.

Upon the arrival of the St. Louis in port the officers and crew of the Veendam were transferred to the outgoing Holland-American liner which was detained for this purpose, and the official investigation will be held by the Dutch authorities. There was consequently little opportunity for securing any intelligent technical account of the mishap, had any of the officers indeed been disposed to express their views. The facts, as stated by passengers on the lost liner and by the officers of the St. Louis, are briefly:

HOLLAND-AMERICAN LINE STEAMSHIP VEENDAM ENTERING THE PORT OF NEW YORK.

The Veendam sailed with a full cargo and nine cabin and 118 steerage passengers, February 3. When three days out, and then about 600 miles due west of Land's End, England, about 5 o'clock in the evening, a heavy shock was felt by those on board, followed by a stoppage of the engines. There was a rough sea on at the time. The engineers reported the shaft broken and the after compartments rapidly filling. All the available steam pumps were started, and the hand pumps rigged above, and manned by the crew and able-bodied passengers. The water rose steadily, and Captain Stenger made preparations for abandoning the ship. As she lay in the track of

transatlantic steamers, he lit distress signals, which about 1 o'clock the next morning were discerned by a west-bound steamer. This proved to be the liner St. Louis, Captain Randle. In response to the request of Captain Stenger three boats were ordered to the rescue of the sinking ship, and in these and one of the boats of the Veendam the crew and passengers were transferred to the St. Louis, without mishap. Captain Stenger, before leaving, set fire to his ship, which was then so deeply immersed that the lower row of port holes was below water.

When rescued the navigating officers of the Veendam expressed the belief that the ship had collided with a derelict, which had torn a hole in the stern and broken the shaft. This, however, is highly improbable. All the circumstances so far as yet known point to the breaking of the tail shaft in the stern tube, between the bearings, with the result that the outboard end, weighted down by the propeller, came into violent contact with the surrounding metal, and the energy stored up in the propeller was expended in breaking the stern tube and the aft framing, letting in the water. The engines were stopped promptly when the break occurred and were not injured, as, owing to the roughness of the weather, the engineer on watch was standing by. An immediate inrush of water through the tunnel, the door of which was probably open, flooded the engine room, and meanwhile the after compartment was filling through the rents in the skin. When the after compartments filled the head of water probably sprung the doors leading into the compartments forward of the engines, and the fires were drowned out. Meanwhile, however, the donkey boiler was fired up, and steam was thus kept on the dynamo engines.

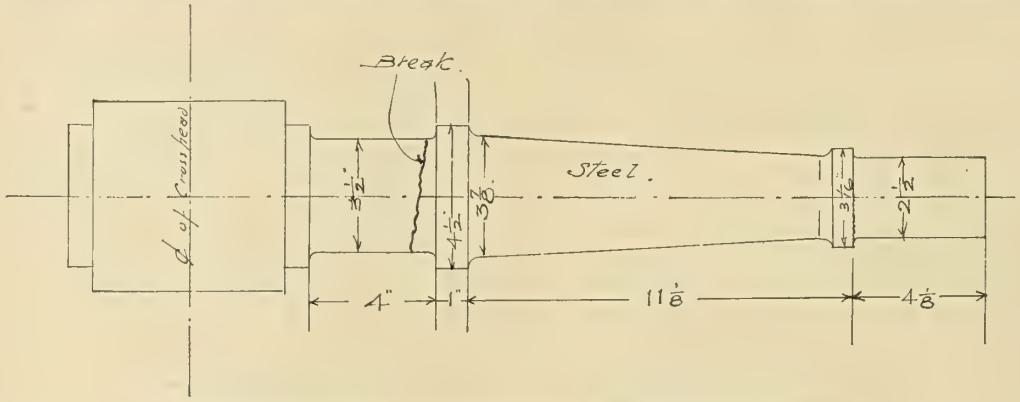
Our illustration shows the Veendam steaming up the North River, in New York harbor. She was an iron single screw vessel, built in 1871 by Harland and Wolff, at Belfast, Ireland, for the White Star Line, under whose flag she was known for many years as the Baltic. She was a strong, good seaboat, and represented the best practice of her time. Her dimensions were: Length, 420 ft.; breadth, 40 ft. 9 in., and depth, 31 ft. Originally she was fitted with compound engines, but when transferred to the Dutch flag she was refitted with new triple expansion engines. At the time of her loss she was valued at $200,000, and the cargo about $300,000.

Accident to C. & O. Transfer Steamer Louise.

On the morning of January 18, while making her usual trip to Newport News from Norfolk, the transfer steamer Louise, of the Chesapeake and Ohio R. R., met with an accident that almost completely destroyed her engine.

While the piston of the single cylinder beam engine was on the up stroke, the port side of the crosshead broke, completely disengaging the port side rod, thus throwing the whole strain and creating a heavy bending moment on the starboard rod. This rod bent, breaking the side gibs, and the rod gave away, allowing the piston to fly up against the top cylinder head. This latter was broken into numberless pieces, one of which came near killing the Engineer.

Before the piston and rod fell, the walking beam, carried by the momentum of the wheel, returned on its downward movement and catching the top end of the piston rod bent it over toward the shaft, thus splitting the cylinder for about six feet of its length. This

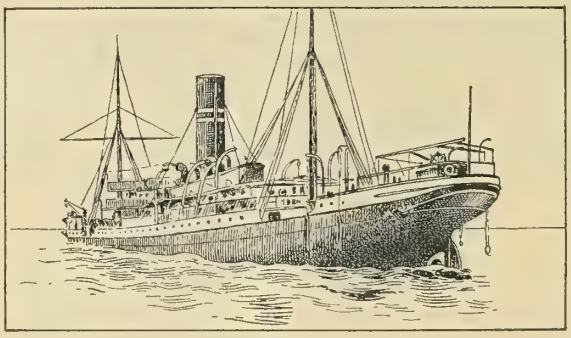


SKETCH SHOWING BREAK IN CROSSHEAD OF TRANSFER STEAMER LOUISE.

also broke the wrought iron strap of the beam, thus causing the breaking of the air pump rods and a number of the holding down bolts of the walking beam bearing caps. The accompanying sketch shows the wrought steel crosshead and the point at which it broke.

It is interesting to note how complete was the chain of circumstances which caused this damage. The break occurred when the piston had traveled about one-third of its stroke, about the point of greatest combined pressure and momentum, and the force of the blow was more than could be expected of any engine to withstand. Had the piston been nearer the end of its stroke the cushion and the reduced forward pressure might have counteracted each other, and thus lessened the extent of the breakdown to a very material degree.

At the time of the accident the engine was making about twenty-two revolutions per minute, under a steam pressure at gauge of 65 pounds.



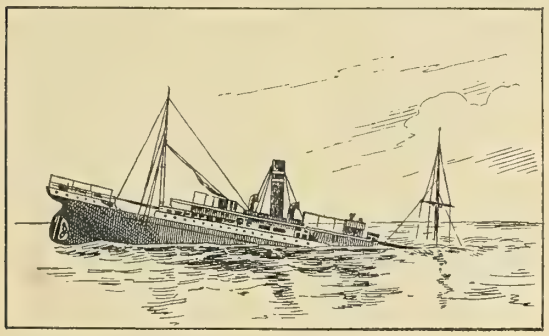
S. S. TAI-HOKU—DOWN BY THE HEAD.

A close estimate would put the damage at about $4,000. She is being repaired at Baltimore, Md.

Loss of the Japanese S.S. Tai-Hoku.

Among oddities in marine photography, a set of views taken by Cecil Lightfoot, of London, of the sinking of the steamship Tai-Hoku off the Portuguese

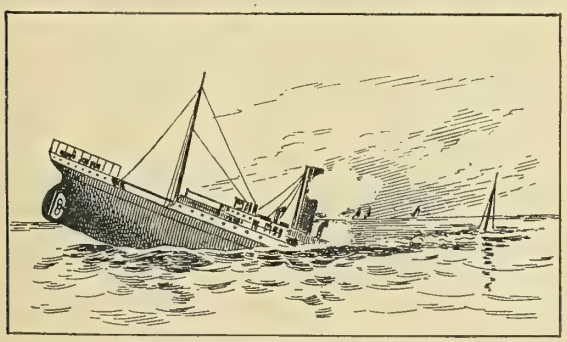
coast, is unique. The views which we here reproduce were originally published in the Strand Magazine, together with an account of the mishap. The steamship had been built at an English East Coast yard for the Osaka Steam Navigation Co., of Japan, and was in every respect an up-to-date passenger liner. She left Antwerp with a miscellaneous cargo, and when five days out, in a thick fog, was run down by the freight steamer Eastbourne. After the collision the Eastbourne dropped out of sight, and the Tai-Hoku was found to have 5 ft. of water in the forehold. So far as any observation of the exterior of the hull went



S. S. TAI-HOKU—GOING DEEPER.

the steamer did not appear to be damaged. Nevertheless the inflow of water continued, and by next morning there was 16 ft. of water in the forehold. Captain Conradi determined to stay with the ship, however, but was unable to communicate with other passing vessels owing to the density of the fog. When the carpenter reported 22 ft. the captain ordered the crew into the boats, and Mr. Lightfoot brought his portable camera away with him.

"After taking to the boats," he said, "we remained very near the ship—within a hundred yards or so. By this time day had dawned, and I was able to take the first two photographs. There was, however, a considerable interval between them. After two or three hours, a large vessel, which proved to be the Millfield, of Whitby, bore down upon us, in response to our flag signal. The captain of this ship conferred with our own commander as to the desirability of towing the Tai-Hoku, and Captain Conradi and some of the officers once more went on board their ship to make the necessary arrangements. Immediately, afterwards, however, the sinking steamer began to

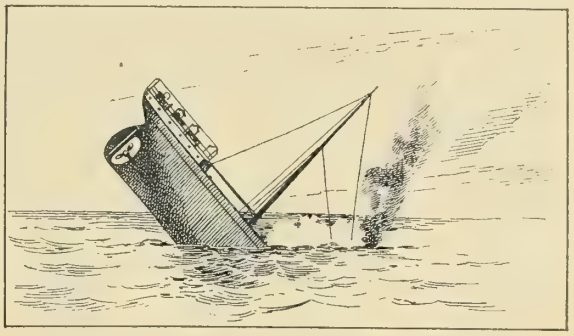


S. S. TAI-HOKU—LAST FEW MOMENTS.

roll heavily, and the attempts at towing had to be abandoned.

"At our request, the Millfield left us immediately after this, she being in a hurry to get home. It was our intention to row up the Tagus to Lisbon, but the crew being of poor quality, this proved a pretty difficult matter. At any rate, we determined to see the last of our ship. The end was now very near. One extraordinary occurrence that hastened it was the displacement of some of the machinery, which, as the Tai-Hoku's head began to go down, and her stern to come up, fell right through the ship with a rumbling sound like distant thunder, and doubtless made another great breach in the bow.

"After another period of anxious waiting, the bridge fell forward, at the same time jerking the cords that communicated with the sirens, and causing them to send a wierd scream over the waters. The next moment, having, so to speak, wished us farewell, the huge ship dived deliberately head-foremost into 300 ft. of water, and was never seen again. As the sea



S. S. TAI-HOKU—THE FINAL PLUNGE.

rushed into the furnaces, steam and water gas were generated; and these, rushing up through the smokestack, caused a kind of explosion, which is very plainly seen in the last photograph I took, just as the ship was disappearing. The upward rush of steam carried a great quantity of soot from the flues, and this caused a dark cloud to hover over the place where the Tai-Hoku sank. There was no whirlpool of any kind. When this great vessel of 3,100 tons took her last dive, the little flotilla of boats could not have been more than 150 yds. distant. Standing by after her disappearance, we saw pathetic bits of wreckage coming slowly to the top—hen coops, a boat, fire buckets, seats, life belts, and so on.

"When we had seen the last of our ship we set to work to row to Lisbon. At about two miles from land a vessel bore down upon us and met us at Cascaes Bay, a little to the north of the River Tagus. She proved to be a Portuguese pilot cutter."

The Tai-Hoku was about 330 ft. long, 43 ft. beam and 28 ft. deep. With her cargo she was insured for $500,000.

Burning of the S.S. Stockholm City.

The tramp steamer Stockholm City, 1,759 net tons, arrived at Newport News recently, badly damaged after a desperate battle with fire at sea. Captain E. J. Richards reported that on January 17, at 5 o'clock in the morning, smoke was observed arising from the starboard coal bunkers amidships. All the pumps were immediately started, and the crew began to dig into the bunkers to try and reach the seat of the fire, but this was useless, for an hour later the flames burst out through the side of the starboard alleyway, showing that the combustion must have been going on for some hours. Immediately the flames mounted to the deck, and although all hands were hard at work, the fire gained complete mastery of the midship part of the vessel.

After burning fiercely for several hours the fire was held under partial control, and although it burned for five or six days after, constant watchfulness and unremitting labor saved the ship. All charts, nautical instruments, books and provisions were destroyed; also the personal effects of the officers. But two boats only were saved, one badly damaged.

The officers, engineers and crew worked like men, but the firemen showed a cowardly spirit. They came

aft, and, after eating the few loaves of bread that were left, hoisted a distress signal, consisting of a bucket and one of their blankets, which was promptly lowered by the Captain. When the vessel reached dock her sides and deck houses were found to have bulged out in places to the extent of 3 in.; all her upper works were destroyed, and it was evident that she had stood all that was possible without sinking. She was completely gutted amidships, bridge and steam steering gear gone, and the engine saved only by almost superhuman exertion. At the time the fire broke out the ship was about 550 miles west by south of Cape Henry, and as all the charts and instruments had been destroyed except the compass in the hand steering compartment aft, and this not having been adjusted, the Captain was rather puzzled as to what to do. Eventually he steered due south until parallel with Cape Henry, and then with the North Star abeam he made a direct course for the Chesapeake, reaching his port in two days and a half.

The damage will amount to about $35,000; temporary repairs are being made by the Newport News Shipbuilding and Dry Dock Co. The engine is a compound 38 in. and 71 in. by 45 in. stroke, and is but slightly damaged, although the walls of its compartment are bulged and strained, and during the return trip the temperature was fearfully high. The fire is supposed to be due to spontaneous combustion.

Other Recent Steamship Losses.

The loss of the steamer Clara Nevada in the Alaska trade, off Seaward City, in Berner's Bay with 25 passengers and crew, was reported. She is supposed to have been destroyed by an explosion.

Captain William Scroggie and the officers of the British steamship Dago were taken from their ship in mid-ocean by the North German Lloyd liner Aller and landed in New York. The Dago was on a voyage from Leith to Baltimore in ballast, and when eight days out the main steam pipe broke. Repairs could not be made, and the pounding of the heavy seas caused the Dago to spring a leak. The water finally drowned out the fires and stopped the pumps, and the vessel was in a sinking condition when the Aller was sighted. A life boat from the Aller took off the crew of the Dago after three trips in a terrific sea.

During a heavy gale the steamer Tillie foundered off Barnegat, causing the loss of several lives of persons on board. It was generally understood that she was engaged in a filibustering expedition, carrying men and munitions to the Cuban insurgents. The Tillie was a wooden steamer, built in 1862, and had been used for many years as a freight carrier by the Vermont Railroad Co. On her last voyage she cleared for Tampa, but was supposed to have taken aboard her cargo of war material from a lighter, off Montauk Point. She developed dangerous leaks when the weather got stormy. When the question of sinking became a matter of time only a cowardly spirit was manifested by those on board. Two boats were lowered and filled dangerously full, and these pulled away, leaving Captain Berry and seven others on the sinking ship. About this time the big five-masted schooner Governor Ames came along and rescued those in the boats, and also sent a boat to the Tillie and took off four of those still on board. According to the reports of the survivors the Tillie went down before the boat from the Ames could make a second trip. All sorts of ridiculous stories regarding damage to the machinery were subsequently published in the daily papers, the loss being attributed to the work of a Spanish spy. In reality the only cause of surprise would have been the safe arrival of the Tillie at Cuba. She was an old boat, staunch enough in the still waters of a harbor, but not fitted to encounter rough weather, which caused the opening of her seams.

CORRESPONDENCE.

Continued Discussion of Walschaert Valve Gear.

Your correspondent is quite right in his conclusion that there is no diagram like Zeuner's circular diagram, that can be applied to radial valve gears. The Walschaert gear is the most regular and symmetrical of any of the common forms of radial gears, and I know from trial that Zeuner's circular diagram does not give even approximate results for it, and that the irregularities of such gears as the Marshall gear and the Joy gear are larger. The only satisfactory way of studying any radial gear, or for that matter any link-motion, is by the aid of a model, but the model for such a purpose need not be very elaborate or expensive. In fact there is a decided advantage in using a model made of wood and laid out on a drawing table as I have shown in my *"Valve Gears for Steam Engines,"* for then, geometric constructions can be made in connection with the model, and in many cases results can be obtained directly instead of by the cut-and-try method.

I have given a figure to show how a complete wooden model can be made for the gear given in connection with my communication in your January number. The crank and eccentric are represented by a flat plate, with a screw for the bearing at the middle of the shaft. The center of the eccentric is at the middle of the small dotted circle which represents a disk of wood or other convenient substance, and which must be large enough to take three screws to fasten on the return crank, which reaches from the eccentric to the crank pin. This inversion of the construction as compared with the gear itself where the eccentric is replaced by a pin in the end of a return crank from the crank pin, is convenient and is of course, proper for a model which gives motions only and does not transmit power.

The cross head is a block moving in guides on which the stroke and its fractions may be laid off, and carries the offset for the link connecting it to the combining lever. The valve-rod head is also a block moving in guides on which the inside and outside laps can be laid off.

The link is represented as cut from a board; it may be convenient to make the bearing surface of the slot of brass plates that can be cut to the right radius independently and adjusted to let the link-block move freely with little backlash. On the back of the link a brass plate may be secured by screws passing through straight slots in the link as shown, so that it may be moved inside or outside of the link arc as may be desired. A screw through this plate into the table or drawing-board will serve as the trunnion.

The several links, rods, and levers are strips of hard wood fastened together with counter-sunk screws.

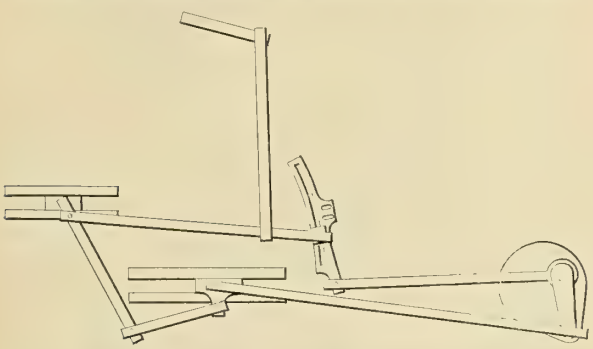
Such a model may appear crude at first sight, but if properly made and used it will give accurate and correct results, and will endure considerable service. It is needless to say that the dimensions must be laid off accurately, but some discretion must be used to maintain them in the process of drilling the holes and putting in the screws. After the location of a screw is determined, take a center-punch ground to a sharp, true point, hold it squarely in place and hit it a square blow with a hammer. Then take the piece of wood to a lathe or a good rapid drill-press and drill the hole with a twist drill. A hole into which a screw is set should be drilled a little smaller than the shank of the screw at the thread, and a hole in which a screw acts as a pin must be a little smaller than the body of the screw, under the head. The head should be V shaped and counter-sunk, as it then forms a cone bearing by which wear can be taken up.

It will be noted that there are four heights or planes of elevation above the drawing-board or table.

The plate for the crank and eccentric, the link, and the two slides representing the crosshead and valve-rod head, are next to the table, as is also the arm of the reverse arm. -The -eccentric rod, combination lever and the link block are at the next stage of elevation. The return crank, the radius rod and the link from the crosshead to the combination lever are at a third height, while the connecting rod and suspension link or hanger are at a fourth height. Distance pieces will be required at places, as for example between the hanger and reverse arm.

The greater part of the dimensions and proportions of this or any other valve gear are imposed upon the diagram by the general construction of the engine. Thus the piston rod and valve rod will have their relation determined by the size and proportions of the cylinder and the valve with its steam chest and passages. The combination lever must be long enough to avoid too large an angular displacement from the vertical; 45 deg. should be taken for the maximum displacement, and less should be used when possible. The displacement of the radius rod from the horizontal should not exceed 15 deg.; less is better.

The gear should be set up "square," that is, the link should be erect when the crank is on a dead point and the combination lever should be vertical when the valve is in midposition, and in general all parts should swing or vibrate equal amounts from a vertical, or horizontal, middle, position. It is true that intentional irregularities introduced with discretion



SKETCH SHOWING COMPLETE WOODEN MODEL.

may improve the action of the valve at certain grades, but other irregularities, are certain to result, which may be very undesirable.

There is, however, one point which has a great influence on the adjustment of the gear and which is quite under the control of the designer. That is the trunnion of the link. Normally the trunnion should be on the arc passing through the middle of the slot of the link, but it may be set either inside or outside of that arc, if the designer finds it advisable. It is for this reason that the brass plate carrying the screw representing the trunnion, is made adjustable. This adjustment of the trunnion is symmetrical in its influences, and produces the same effect in backing as in forward gear, and does not interfere with the lead, which remains constant for all grades. Of course the location of the trunnion screw in the table or drawing-board must be changed to correspond with the displacement inside or outside of the arc, assigned to it. Perhaps it will be as well to set up the model with the trunnion on the link arcs and investigate the action of the valve at all grades. Then move the trunnion a definite fraction of an inch, and make another investigation of the action of the valve.

There is, however, a direct way of finding the location of the trunnion for equalizing the cut-off at a certain fraction of the stroke or for any such a purpose. Suppose the first investigation of the valve-action with the trunnion on the link arc has been made, and that the cut-off appears to be unequal at some grade, say at one-third stroke. To equalize the cut-off at that grade proceed as follows: Place the reverse-arm at the right position to give the mean cut-off at one-third stroke; the head-end cut-off will be too long and the crank-end cut-off too short. Place the cross-head at one-third stroke at one end; secure it as well as the reverse-arm by placing weights on them. Secure the eccentric-rod by placing a block under it near the link, and a weight over the block. Now loosen the screws fastening the brass trunnion plate to the link and tip the link till the valve shuts to give cut-off. Note how far the link slides on the trunnion plate, and move the trunnion screw the same distance in the drawing board or table; this will require the link and some other parts of the model to be taken up. Set up the model with the new location of the trunion and make another investigation of the action of the valve. It is probable that there will be some slight inequality of cut-off at the assumed grade, but if the cut-off is practically equalized at one-third stroke the whole action of the valve is likely to be satisfactory. It must be borne in mind, that a half inch inequality at a third cut-off may be of much importance, while an inch inequality at seven-eighths cut-off is of little consequence.

It is possible to get along with only a partial model, completing the work by construction. For example we may use a piece of cardboard on which the link-arc at the middle of the link-slot is drawn, instead of the link with a sliding block; other lines and points may be drawn and located as required on the same cardboard. We shall need also two strips of wood to represent the combination-lever and the radius rod. They should be joined together at the proper place by a pin or screw. It will be convenient to refer to Fig. 1, page 26, of the January number, in the description of the construction to be made with these adjuncts, noting that that figure represents the gear with the crosshead at about three-fourths return stroke. Draw a diagram like Fig. 1, except that the crosshead is to be placed at the fraction of the stroke for which the cut-off is to be equalized, say at one-third stroke. The connecting rod C D, crank A B and eccentric A H are readily located. The point J may now be located by drawing arcs from H and L with the proper radii, and the cardboard link-template can be placed on the drawing with the points I and J at the corresponding points on the drawing. Now locate G at a distance from its middle position equal to the outside lap, that is at the proper place to give cut-off. Take the strips of wood representing the combination lever and the radius rod, and apply to the drawing, one point at G, one on the link-arc and the other on a circle drawn with D as a center and a radius D E; this gives the location K F G E D, and also of the point M. From M locate the point N of the reverse arm P N.

Now make a similar construction for cut-off on the return stroke, thus finding another location of the point N. Clearly these two points should coincide if the cut-off is to be at one-third stroke for both ends. Take a point half way between the two locations of N for its true location. Let G E remain fixed; place a weight on it for that purpose and let F K move up or down as may be required to correspond with the assumed location of N. K will probably be displaced from the link-arc during this operation. If so fix the point J and tip the link until it comes to the point K and note the direction and amount that the point L representing the trunnion on the link template is shifted from the point I on the drawing board. This is the amount by which the trunnion is to be set off from the link-arc. This construction must be made with much care and accuracy, and is liable to more error than will be found on a properly made model. It is hardly necessary to point out the advantage of the model in that all the properties of the gear for a given setting can be readily investigated.

C. H. Peabody.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—VII.

BY WM. BAXTER, JR.

The diagrams illustrating the winding of field coils given in the last article represent what is called series winding, this name being given to it because all the current that passes through the armature passes through the field coils. The arrangement is very simple, but is only used for motors that are not desired to run at a constant speed, and for generators that are not desired to maintain either a constant current or a constant electro-motive force, or pressure. Whenever it is desired that the current remain constant, as is the case in arc lighting circuits, some form of mechanical regulator is attached to the machine, but if it is desired that the electro-motive force remain constant, as in incandescent lighting circuits, the result is attained without the complication of mechanical regulators, by resorting to a different style of field winding. This winding, in a generator, will give a constant pressure and in a motor will maintain the speed uniform, provided the current pressure does not change. There are two types of winding used for accomplishing these results, the simplest of these is known as the shunt winding, the other as the compound winding, when applied to generators, and as the differential winding when applied to motors.

The difference between these two styles of winding and the plain series can be understood from Figs. 38 and 39, the first being the shunt, and the second the compound or differential. In the shunt winding only a small portion of the current that passes through the armature passes through the field coils, if the machine is a generator; if it is a motor, all the current supplied to it does not pass through the armature, a small part going by the way of the field coils. Fig. 38 shows this winding applied to a motor. In this case the current is supplied from an external source, and as will be seen from the diagram it passes down the wire P until it reaches the point D where it branches, part going to the commutator brush, and part to the field coils.

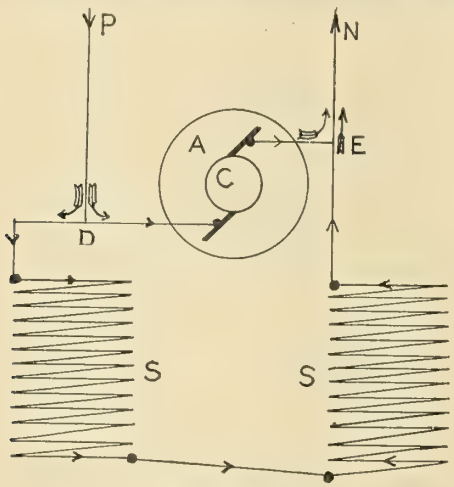


FIG. 38.

The two branch current meet again at E, after one has passed through the armature and the other through the field coils. If this diagram were to represent a generator, the current on reaching the point E would split, and part would pass into wire N and part would go to the field coil. The two currents would come together at D and pass as one to the armature.

The compound winding shown in Fig. 39 is a combination of the series and the shunt. The main practical difference between the shunt and compound windings is, that the latter gives closer regulation. As the principle of operation of the two is substantially the same the explanation of the compound will be clearer after the operation of the shunt is fully comprehended; we will, therefore, proceed to explain in the latter.

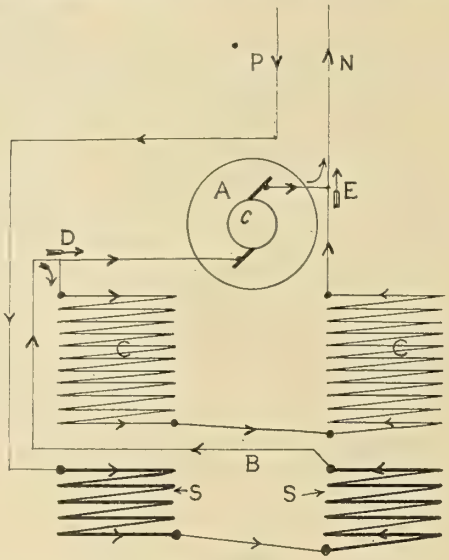


FIG. 39.

As has already been explained, the rotation of an armature in a magnetic field developes in the wire wound upon it an electro-motive force, or electrical pressure, this is true, whether the machine is a generator or a motor, but in the latter this pressure is opposed to that of the current that operates the machine, that is, it is a back pressure, and is therefore called the counter electro-motive force. Whether the electro-motive force is counter, or direct, it will be proportional to the strength of the field, that is to the number of lines of force passing through the armature and the velocity of rotation. If the field remains constant, the electro-motive force will increase with increase of velocity of rotation, and will decrease with decrease of velocity. If the velocity remains constant, the electro-motive force will vary with the strength of the field. If both field and velocity remain constant, the electro-motive force will remain constant. The amount of current that any given electro-motive force will drive through a wire will depend upon the resistance it encounters, being small when the resistance is great and large when the resistance is low. If the resistance is reduced to one-half, the current will be doubled with the same electro-motive force. If the electro-motive force increases and the resistance remains unchanged, the current will increase in direct proportion with the pressure. If pressure and resistance remain unchanged, the current will remain constant.

Remembering the above simple principles, if we regard Fig. 38 as the diagram of a motor, we will see that the current entering through wire P when it reaches the point D will divide between the two paths in amounts proportional to the resistances of the two circuits. The resistance in the field circuit is simply the resistance that the wire opposes to the passage of the current and will remain unchanged, therefore the current passing through the field will be constant as long as the pressure does not vary. The resistance of the armature circuit is made up in part of the resistance of the wire to the passage of the current and in part of the counter electro-motive force, the latter being by far the greatest part of the whole. As the current through the field

coils will remain constant, the magnetism developed thereby will be constant, and as the electro-motive force, or the counter electro-motive force, will not vary at a given velocity as long as the strength of the field remains constant, it follows that a given number of revolutions of the armature will be required to develop an electro-motive force sufficient to balance the direct pressure when the current is of a certain strength. In order to get a given amount of power out of the motor it is necessary to have a certain amount of current passing through the armature, this amount depending upon the pressure. The current is measured by a unit called an ampere, the pressure by a unit called a volt, and the power by the product of the amperes and the volts. This product is measured by a unit called a watt. A current of one ampere and a pressure of one volt will develop a power of one watt. A current of ten amperes with a pressure of one hundred volts will develop a power of one thousand watts. This is what the current would do if there were no loss, but as part of the energy is expended in overcoming the resistance of the wire the full power cannot be recovered, we may therefore say that the watt is the measure of the theoretical value of the current and not the actual power it will develop, the latter depends upon the efficiency of the machine.

As the wire wound upon the armature has resistance, a part of the energy of the current will be used in forcing the current through the wire. The amount will depend upon the resistance. Resistance is measured by a unit called an ohm. A pressure of one volt will force a current of one ampere through a resistance of one ohm, and through ten ohms ten volts would be required to force one ampere. From this we see that when a current passes through a wire part of the pressure is used up in overcoming the resistance, and applying this to the armature it becomes evident, at once, that the counter electro-motive force cannot equal the direct electro motive force, but must be equal to the difference between this and the pressure required to force the current through the wire. If the load upon the motor is constant, the current passing through the armature will necessarily remain constant, and therefore the loss of pressure in overcoming the resistance will be constant, hence the velocity of the armature will not change as it will have to develop the same counter electro-motive force all the time; and this will do at a uniform velocity, providing the strength of the field does not change, and as we have shown this will not change so long as the pressure is constant.

If the load upon the motor is increased, more current will be required in the armature to put forth the extra power, but this additional current cannot be obtained unless the resistance is reduced. If the current is increased, the resistance of the armature wire will absorb a greater amount of the pressure, which will make matters worse, unless the counter electro-motive force is reduced. This is what must be done, but it can only be accomplished by reducing the velocity of the armature; therefore if the load is increased the armature must run slower, and if the load is reduced, it must run faster. The difference in the speed, however, can be made very small by reducing the resistance of the wire on the armature to the lowest point. This can be accomplished by making the wire large and having as few turns as possible. The turns of wire on the armature can be reduced by increasing the strength of the field in proportion, for as has been explained, the pressure developed by the armature is in proportion to the strength of the field and the number of turns of wire, and one can be reduced by increasing the other. If the armature wire has such a low resistance that the pressure absorbed by it when the motor is working to its full power is, say one per cent. of the total pressure of the current, then it is evident that if the load is doubled, which would require double the current, the loss of pressure in wire would only be increased to two per cent, therefore the counter electro-motive force would be reduced to the extent of one per cent and the speed would be one per cent lower than with the normal load. In the same way if the load were reduced to zero, that is if the motor were run light, the loss of pressure in the armature wire, which at full load would be one per cent, would be reduced to a very small fraction of one per cent, and as a result the counter electro-motive force would have to increase about one per cent, and this would require an increase in velocity of the same amount.

From the foregoing it can be seen that to obtain close regulation of speed in a shunt motor it is necessary to make the resistance of the armature wire as low as possible, and the same is true if the machine is a generator instead of a motor. In actual practice, as close regulation as one per cent between full load and no load cannot be obtained if the armature absorbs as much as one per cent of the pressure at full load, because there are certain other losses that tend to change the speed to a somewhat greater extent, but the difference is only slight.

While the shunt wound motor runs at a constant velocity with a constant pressure of the operating current, a shunt wound generator will develop an equally constant pressure if run at a constant velocity. Why it will do so can be easily understood, for suppose the motor just considered were run as a generator and at the same velocity as it ran as a motor, then the back pressure which would now become the direct electro-motive force would be the same as before and the pressure appearing at the commutator brushes would be equal to this amount less that absorbed by the resistance of the armature wire, which, as has been stated, would be one per cent. This pressure would maintain a constant current through the field coils, just as in the case of the motor, and the current passing to the external circuit would be free to vary without changing the electro-motive force developed by armature, since the velocity of rotation and the strength of the field would remain constant.

As a portion of the electrical pressure is absorbed in forcing the current through the wire it follows that if a generator is supplying current to a number of lamps, say one thousand feet away, the pressure at the lamps will be lower than at the generator. Furthermore, the difference in pressure at the two points will vary with the difference in strength of current. To illustrate, suppose the loss of pressure with a current of ten amperes is one volt, then with one hundred amperes it will be ten volts. If the pressure of the generator is 100 volts, at its terminals, it will be ninety-nine volts at the end of the line when the current is ten amperes, and only ninety volts when it is 100 amperes. This drop of pressure would render the current very unsatisfactory. If it were used for operating lamps, the result would be that with a few in use the light would be very bright and with a large number very dim. If used to run a motor, the speed of the latter would change considerably, as the pressure would drop as the load increased. To overcome this difficulty the compound winding is used for generators, and the differential winding for motors. In the compound winding, in addition to the shunt coils there are a set of series coils through which the whole current generated by the armature is passed. As can be seen the effect of these series coils is very small when the current generated by the armature is weak, for they then add but little to the total magnetizing force, but when the current is strong the assistance the shunt coils receive from the series coils is very great. By placing the proper number of turns in these coils any amount of drop of pressure in the line can be compensated for. In the example just given the turns in the series coils would be made sufficient to raise the pressure of the current to about 110 volts with

the current at 100 amperes, and then the pressure at the end of the line would be ninety-nine volts with a strong, as well as a light current. In a motor the series coils are connected so as to work against the shunt coils and this is why it is called differential winding. The action is as follows: If the current through the motor increases, in consequence of an increase in the load, the series coils as they work against the shunt, reduce the strength of the field magnetism, and therefore the counter electro-motive force developed at a given velocity is reduced, since a reduction in field strength reduces the electro-motive force. As by the reduction in field strength a lower counter electro-motive force is developed at the same velocity it follows that the normal speed can be kept up even if the pressure of the current drops, and as in the case of the generator, any drop can be compensated for by placing the proper number of turns in the series coils.

An oil tank steamer for the Standard Oil Co. will be constructed at the yard of John B. Roach, in Chester, Pa. She will be 264 ft. long, 40 ft. beam and 23 ft. 6 in. deep, and will have a capacity of 720,000 gallons. Triple expansion engines with cylinders 21 in., 34 in. and 56 in. by 42 in. stroke will be fitted, with two Scotch boilers 14 ft. 6 in. dia., and 12 ft. 9 in. long, giving steam at 180 lbs. pressure. The general arrangement will differ somewhat from that usually followed, in that the machinery will be placed amidships. Here, also, in a bridge structure, the officers will be housed. There will be bunker capacity for 550 tons of coal.

A fine new machine shop built by the Chicago Shipbuilding Co. consists of a central bay 60 ft. wide and 60 ft. high, served with overhead crane and 2 side bays 3 ft. wide. But three bents, or 120 ft. in length, of the shop have been built, but it can be extended as the necessity arises, to 450 ft. in length, or additional bays, on the saw-tooth roof principle can be added on either side, the iron work being designed for that purpose. The crane girder and columns are built to carry two 25 ton cranes working together. The shop has unobstructed floor room, there being but four columns in a space 120 ft. square. It is also remarkably light. The inside and the tools are painted white, and on a dark day, from the number of cross reflections, it is actually lighter than it is outside. The heating arrangement consists of a hot air system with steam coil and fan, installed by the American Blower Co., of Detroit. The 25 ton electric crane is by the Brown Hoisting and Conveying Machine Co., of Cleveland, O. In each side bay there is a 5 ton hand crane. The tools were nearly all furnished by the Niles Tool Works Co., of Hamilton, Ohio, and include a floor boring, drilling and milling machine of special design. The horizontal travel is 16 ft., vertical, 10 ft., and the spindle feeds in 6 ft., the bed plate being 20 ft. square, with an 8 ft. circular table having 3 ft. power cross feed. The big lathe is 72 in. swing by 25 ft. between centers, and there is the usual outfit of planers, slotters, radial drill, shapers, small lathes, etc. The small tools in each bay are served from one line of shafting, driven by a motor at the end. The floor boring machine and big lathe have separate motors attached. This leaves the main floor of the shop entirely clear of belts. All motors used are by the Elwell-Parker Electric Co., of Cleveland, Ohio, who also furnished the generator which runs them and the motors for the rest of the ship yard plant which was changed to motor drive in all departments on the central power house system when this shop was finished. The shop was designed by the Wellman-Seaver Engineering Co. in accordance with the suggestions of W. J. Babcock, manager of the company, and was built by the ship yard force.

ENGINEERS' DICTIONARY.—III.

Banked Fires.—A condition of the fires in the furnaces of a boiler in which all the combustible is heaped up on one part of the grate and covered with fresh coal, the dampers and draft regulators being so arranged as to allow only very slow combustion. Under these conditions, when there is little or no demand for steam from the boilers, the temperature and pressure can be maintained with but slight active formation of steam, while on the fires being spread and the draft applied, steam will be rapidly formed for use as may be required. Fires are usually banked during stops of a few hours, or when for any purpose it is desired to maintain the machinery in a condition to get under way with the least possible delay.

Bearing.—A general term applied to such portions of a machine as are used to support or constrain a rotating shaft. It is also frequently used in a wider sense as a general name for any surface which provides support or constraint. Using the term in the first sense, the most important bearings in a marine engine are those for the shaft. The bearings for the crank shaft are called *crank shaft bearings*, *main bearings*, or *main pillow blocks*. The bearings aft of the engine and used chiefly for the support of the shaft are called *spring* or *line shaft bearings*. The bearing formed where the shaft passes out through the stern, or through the side with twin screw ships, is called the *stern* or *outboard* or *tailshaft bearing*. The bearing formed in the after supporting bracket used with twin screws, is called the *after* or *stern bracket bearing*. The bearing provided for transmitting the thrust from the shaft to the ship is called the *thrust bearing*.

Bearing Bars.—Bars running across the furnace of a boiler for the support of the grate- or fire-bars.

Bed Plate.—In general the base or foundation part of an engine or other machine. With the usual type of marine engine, the bed plate supports the columns on either side, and serves to connect them with the engine-seating as part of the ship, while along the center it supports the crank shaft bearings or pillow blocks. The bed plate must provide sufficient strength to withstand the internal stresses arising in the engine, and sufficient stiffness to prevent sensible bending or departure from the lines of correct adjustment. Cast iron and cast steel are the usual materials used, the latter to a slowly increasing extent.

Bell Crank.—A bent lever, as illustrated by A. B. C. in Fig. 4, for changing the direction of reciprocating or to and fro motion. Frequent examples are met with in indicator reducing gear, starting gear, etc.

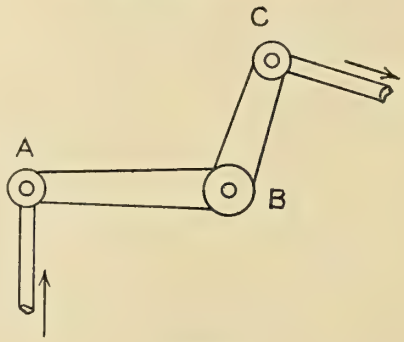


FIG. 4.

Bilge Injection.—A valve and pipe for connecting the circulating pump inflow with the bilge. By this means the circulating pump may be used as a bilge pump in case of emergency.

Bilge Ejector or *Bilge Siphon.*—(Fig. 5.) A form of steam "injector," used for clearing the bilge of water. A is the steam pipe, C the nozzle, B the pipe leading to the bilge, and D that leading to the discharge. Such an arrangement can lift the water but a small distance, and for best results should be put down near the level of the water to be handled.

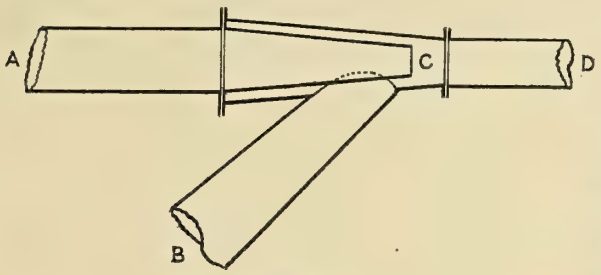


FIG. 5.

Bilge Suction.—A general term applied to the pipe leading from a bilge pump to the *well* or point of inflow.

Black Lead.—A common name for *graphite*, one of the forms of carbon. Graphite is much used as a lubricant in modern engineering practice, either alone or in combination with grease or oil. It is also used as the base of paints for metallic surfaces.

Bleeder.—A pipe leading from the main steam pipe direct to the condenser. It thus constitutes a *by-pass* or shunt for the steam past the engine. It is used to control the steam pressure in the boilers when stopping, or when lying with heavy fires and ready to get under way. Its use avoids the necessity of opening the safety valve, with the consequent loss of steam through the escape pipe, and the resulting loss of fresh water from the boiler. The air and circulating pumps must, of course, be independent of the main engine in order to make use of such a device.

Blow Cock or *Blow Valve.*—A cock or valve allowing water to be blown or forced through the *blow-off pipe* out through the bottom or side of the ship, and thus discharged from the boiler. When the pipe is led from the bottom of the boiler the fitting is called the *bottom blow* or, sometimes, the *mud blow* or *mud cock*, and it is used to remove mud sediment and scale from the bottom of the boiler. When the pipe is led from near the surface of the water in the boiler it is called the *surface blow* or *scum cock*, and it is used to remove the oily scum which gradually accumulates in all marine boilers on the surface of the water. Modern marine boilers are usually fitted with both bottom and surface blows. All blow-off pipes should have as straight a lead as possible, and should be fitted with plug-cocks or straight-way (the latter preferably) rather than globe valves. Their size should preferably not be less than 2 in. to 2 1-2 in. dia.

Blower or *Fan.*—A machine for handling large volumes of air under light pressure and used for the ventilation of ships, forcing the draft of boilers, etc. The modern blower consists of a shaft carrying several blades or fans, surrounded by a casing and operated by an engine usually attached to the casing or to the same bed plate. The direct result of the revolution of the fan is a corresponding revolution of the air, in consequence of which the centrifugal force developed causes a movement toward the tips of the blades or outer shell of the casing. An outlet is here provided, and hence the air escapes, driven by the pressure due to the centrifugal force. Its place is taken by air entering at the inflow near the center of the fan, and so long as the latter is in motion the result is a continuous stream of air from the outlet issuing at a velocity depending on the speed of the fan and other circumstances.

QUERIES AND ANSWERS.

Q.—The engines of my ship, when towing a barge, make 68 revolutions per minute, and when not towing make 73 revolutions per minute; the steam and vacuum and everything being the same. Where does the loss of horse power come in? By figuring at 68 revolutions I get considerable less than 73 revolutions. TEXAS.

A.—For the explanation of the conditions which you describe, let us assume certain data which you have not given.

Suppose the resistance of the barge to be 70 per cent. that of the ship, and that with the barge the speed attained is 8 knots. Then without the barge the resistance of the ship at this speed will be $\frac{100}{170} = .588$ of the total value with the barge. Supposing resistance to vary about as the square of the speed, then the speed at which the ship alone will have the same resistance as the ship and barge at 8 knots, will be not far from $8 \times \sqrt{1.70} = 10.4$k. Suppose furthermore, the pitch of the wheel to be 17 ft. Then at 10.4 knots and 73 revolutions the slip will be 15 per cent., while at 8 knots and 68 revolutions the slip will be 30 per cent. We can now explain what occurs:

Suppose the ship towing the barge at 68 revolutions and 30 per cent. slip and making 8 knots with a certain steam pressure and position of cut-off. Then, with no change in the steam or cut-off, suppose the barge to be cast off. The mean pressures, turning effort, and thrust remain the same. The resistance of the ship, however, is now less than the developed thrust, and she will, therefore, increase in speed and revolutions until a new condition of equilibrium is found at a speed of 10.4 knots, 73 revolutions, and 15 per cent. slip. While the thrust and resistance are therefore the same as under the former conditions, the speed has increased from 8 to 10.4 knots or by $2.4 \div 8.0 = 30$ per cent. of its former value, and hence the useful work has increased in the same proportion, while the required work in the engine has only increased, due to the rise of revolutions, or in the ratio $5 \div 68 = 7.4$ per cent. that is, the work required to drive the ship 10.4 knots at 73 revolutions and 15 per cent. slip is 7.4 per cent. greater than that required for the ship and barge at 8 knots with 68 revolutions and 30 per cent. slip, and this increase of 7.4 per cent. in the required work is attended by an increase of 30 per cent. in the useful work. The loss of work in towing comes therefore from the necessarily high value of the slip, and consequent low propulsive efficiency. The reference of the problem to the speeds developed in the two cases shows plainly their relation, and why more power is developed light than loaded at the same steam pressure. The figures assumed above are merely illustrative; the same principles, however, will apply to any other values so long as they are mutually consistent.

Another illustration of these principles is found in the fact that with a vessel tied to a dock, as in a machinery dock trial, the revolutions and power developed are less than when in free route with the same steam pressure.

Q.—In using soft coal under the boilers on tugboats I find that the tubes and smoke box get clogged up with a deposit of soot, which shuts off the draft, causing the boiler to steam hard. The tubes must be swept either by hand or steam about every other day. I suppose this soot is a deposit of hydrocarbons from the smoke, and would like to know if there is any element or compound which, if introduced under the boiler, might eliminate this objectionable deposit. How would it do to burn zinc occasionally? Please also advise what the composition of the average soot from bituminous coal is, and why anthracite coal does not leave a deposit in the tubes? H. B. Y.

A.—As you suppose, soot is a deposit or precipitate from unconsumed or partially consumed hydrocarbon gases. Stating the formation in chemical language, it may be said that if an unoxidized or partially oxidized hydrocarbon gas is suddenly cooled, the carbon is precipitated out in an amorphous or non-crystalline form, and is deposited on the surfaces from which the cooling action comes. Soot is much more abundant with soft or bituminous coal than with anthracite, simply because the former is rich in hydrocarbon compounds, and the latter poor. A true anthracite coal has little or no hydrocarbons, and hence produces no appreciable soot, while on the other hand, the richer a coal in such compounds, the more extensive may be the soot formation. The principal constituents of soot are carbon, volatile matter and ash. The relative proportions are quite variable, dependent on the special conditions. The volatile matter is simply a certain portion of hydrocarbon gas which is presumably absorbed by the other constituents without precipitation of the contained carbon. The ash is simply a part of the non-combustible matter in the smoke which is caught and mechanically mixed with the other constituents.

The only way in which the deposition of soot can be prevented is by a complete oxidation or burning of the hydrocarbons before they reach the relatively cool tubes. If the carbon is all oxidized to the form CO_2 or carbon dioxide, it cannot be precipitated out as soot. One of the chief purposes of the combustion chamber is to provide a place where such combustion may be completed. In order to accomplish this, however, the temperature must be maintained very high, and an intimate mixing of the gases given off by the coal with free oxygen in the air supply must be brought about. It is for this purpose that recently use has been made of bundles of small jets delivering hot air under high pressure into the furnaces or combustion chambers. These act as so many mixers or stirring rods, and are intended to bring about the intimate mixture necessary for complete combustion.

Once deposited, we know of no better way for the removal of soot than by the steam or hand sweep. The resources of chemistry do not so readily adapt themselves to its removal as might be expected. The burning of substances like zinc would result in the oxidation of the zinc in the furnace, and its partial reduction back to metallic zinc on the soot, the corresponding amount of soot being thereby removed as carbon dioxide. This would result in a deposit of metallic zinc with the soot, for the action would be only partial, and the soot removed would, in our opinion, be out of all proportion, small in comparison with the cost of the zinc burned.

Q.—What would be the gain in saving of fuel by putting in an iron coil feed heater in the smokestack, to by-pass through before entering the boiler?

MUSKEGON.

A.—The gain to be derived from the use of a feed water heater cannot be stated off hand, or in general terms, as it will depend on the particular circumstances of the case. The especial purpose of the heater is to absorb by the cool feed-water a portion of the heat which would otherwise escape up the stack. If then the supply of heating surface in the boiler is abundant and efficient in action and the gases are delivered to the base of the stack at a fairly low temperature, such, for example, as 450 deg. to 500 deg. the gain to be derived from the use of the heater would be small. If on the other hand the heating surface is deficient in amount or inefficient in action, and the gases are delivered to the stack at a temperature of 700 deg. to 800 deg., the gain by the use of a properly designed and fitted heater would be pronounced. In no ordinary case, however, will the gain be more than from 15 to 20 per cent., while in the cases commonly met with, a gain of half these figures would be considered quite satisfactory.

The most important secondary point in connection with a stack feed heater is its possible influence on the draft. If the space within which the heater is to be fitted cannot be made considerably larger than the cross section of the stack itself, a decrease of the area for the passage of the gases will result, and a consequent loss of draft, unless made up by aid of a blower. The heater should be so fitted that the net cross sectional area between the pipes is at least as great as, and preferably greater than, that of the stack.

Q.—Will you please give me the rule for finding the pitch of a propeller?

W. C., Boston, and W. H. C.

A.—To determine the pitch of a given propeller three measurements are necessary. These are:

(1.) The radius O A at which the pitch is desired.

(2.) The angle or part of the complete circumference corresponding to the distance on the blade between A and B. The two points between which the pitch is to be found.

(3.) The advance B C along the line of the shaft, corresponding to this part of the complete revolution.

In the figure, A and B are points on the face of the blade, and are at a constant distance O A from the shaft center line O O. A C is an arc of a circle which lies in a plane through A, and perpendicular to the shaft. The angle A O C is therefore the one referred to in (2), and the distance B C is the corresponding advance. Then B C is the same fraction of the entire pitch that A O C is of a complete circle, or that the length A C is of a complete circumference with O A as radius. This complete circumference will be $6.2832 \times$ O A. Hence the proportion:

$$A\ C : 6.2832\ O\ A : : B\ C : \text{pitch}$$

$$\text{or pitch} = \frac{6.2832 \times O\ A \times B\ C}{A\ C}$$

A C is, however, not as easy to measure as A B, so that we may put for A C its equal, $\sqrt{\overline{A\ B}^2 - \overline{B\ C}^2}$ and hence

$$\text{pitch} = \frac{6.2832\ O\ A \times B\ C}{\sqrt{\overline{A\ B}^2 - \overline{B\ C}^2}}$$

A brief outline of the operation is as follows: (1) Select the points A and B at and between which the pitch is desired, making sure that O A = O C, and lay out on the blade a line A B at a constant radial distance equal to O A from the center line of the shaft. This can be done by squaring down from a straight-edge or other reference line P O P R placed across the hub and at right angles with the shaft. Measure the length A B.

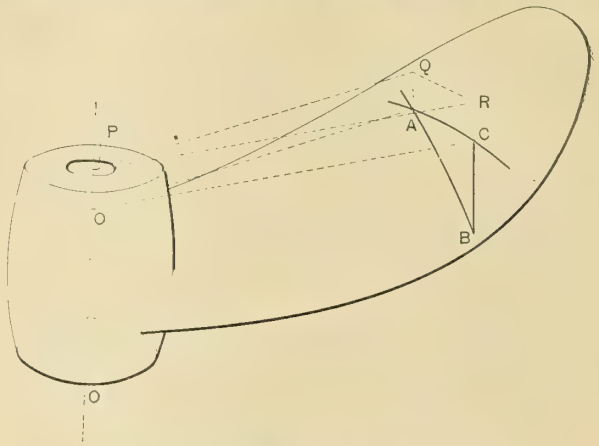
(2.) The propeller being leveled up, measure the distance B C from a level through A vertically down to B. Or if the propeller cannot be leveled, measure from B in a direction parallel to the shaft out to a line through A and running at right angles to the shaft. Or measure from Q down to A and from R down to C, and take their difference B C.

(3.) Multiply the radius O A by 6.2832 and by the length B C all in the same units of measure.

(4.) Square the lengths A B and B C, subtract the square of the latter from that of the former, and take the square root of the remainder.

(5.) Divide the result found in (3) by that found in (4) and the result will be the pitch desired.

Thus for example suppose A B = 15 inches, B C = 9 inches, and O A = 40 inches. Then $6.2832 \times 40 \times 9 = 2262$. Also $\sqrt{225 - 81} = 12$ and $2262 \div 12 = 188.5$ inches $= 15.7$ feet = pitch.



SKETCH SHOWING METHOD OF FINDING PITCH.

The foregoing assumes the propeller to be of uniform pitch. If instead the pitch is variable, the operation is precisely the same, but the result found must be considered merely as the mean or average value of the pitch between the points A and B. For other parts of the blade a similar process will give the corresponding pitch.

As a rough and ready rule it may be remembered that the pitch of a propeller will equal the length of a circumference at the place on the blade where the slope of the face is 45°, or where it is equally inclined to the shaft and to the transverse direction. Starting near the shaft the inclination to the longitudinal is small, but increases toward the tip. Let r be the radius where the inclination is the same to both directions, then $p = 2\pi r = 6.2832$ r. In this way an approximate idea may be obtained of the pitch of a wheel by estimate without special measurement, except for the radius or diameter at which the condition of equality of slope is fulfilled.

The details of the general method as described may be varied in many ways, but the description given will serve to show the general principles involved, and with a reasonable amount of mechanical skill, no trouble will be found in carrying out the measurements required.

Q.—To whom should one apply for a position as oiler on the American liners St. Paul or St. Louis? Also what qualifications are necessary to secure such a position? J. E. L.

A.—The oilers on the ships you name are men who have been promoted from firemen, and the firemen are usually engaged from a shipping master. On the big ships they usually like to have only men who have had sea experience. If the applicant has not had such experience, it would be better to try for a position as oiler on a coasting vessel or on a transatlantic freighter, as these boats will take new hands, usually by applying to the Chief Engineer. The work would be much lighter and much valuable experience could be secured. No special qualifications are required, other, of course, than good health, a record for sobriety, and average intelligence; but chances of promotion are slim, in the transatlantic trade, unless the applicant has received a good training as a machinist.

The Engineer's Reference, published by the Reference Publishing Co., World Building, New York, is the name selected for a most complete directory, properly classified and indexed, of manufacturers and dealers in all kinds of materials and apparatus, used in and about steam and electric plants, in the Greater New York. It is a valuable guide in the purchase of supplies and apparatus, giving in a convenient form the names of responsible concerns in this line of trade.

DURING THE MONTH.

The new steamer for the Catskill and New York Steamboat Co., for which W. & A. Fletcher, of Hoboken, have the contract, will be named the "Onteora."

According to present indications, the insolvent Anchor Line, operating steamers on the Mississippi between St. Louis and New Orleans, will be reorganized and new boats added to the fleet.

The torpedo boat MacKenzie was launched at the yard of the Hillman Ship and Engine Building Co. She is a 100 ft. boat, fitted with a single screw, and is expected to develop a speed of about 20 knots.

When the American liner New York was being got ready for her trip out on February 2 a flaw was discovered in the port thrust shaft. The sailing date was canceled, and the ship taken over to Jersey City to await a new shaft, which was immediately ordered.

A contract for the construction of a steamship for the Virginia and Carolina Chemical Co. was awarded Harlan and Hollingsworth. Her dimensions are given as: Length, 275 ft.; breadth, 41 ft.; depth, 22 ft. The machinery is to consist of a triple expansion engine 18 in., 28 in. and 45 in. by 42 in. stroke, working at 160 lbs.

The Manhattan Steamship Co., organized to operate a line of steamers between New York, Maine and Canadian ports, is figuring on plans for new steel vessels. The officers of the new company are: Jonathan J. Hillman, president; Joseph D. Huggins, vice-president; N. L. Newcomb, general manager; Henry E. Alexander, treasurer, and William F. Weiss, secretary.

At the yard of Harlan and Hollingsworth, in Wilmington, the twin screw steam yatch Niagara, for Howard Gould, of New York, was successfully launched. This powerful vessel is 272 ft. long, 36 ft. beam, and 27 ft. deep. She will be fitted out in modern style, and in the points of comfort and convenience especially will be one of the finest pleasure vessels afloat.

Plans for a new lake steamer for Captain John Mitchel and others are now being worked out by the Globe Iron Works Co. at Cleveland. This vessel will be a large freighter, and will have a machinery equipment designed somewhat upon the lines of the machinery of the S.S. Inchmona, referred to in our last issue. This will include boilers to carry 230 lbs. pressure, fitted with hot draft and quadruple expansion engines.

The sale of the steam yacht Mayflower (described in our issue of August, 1897), the property of the estate of the late Ogden Goelet, to a European agent was effected through Tams and Lemoine, of New York. The price paid is said to have been $400,000, and the new owner to be none other than Leopold, King of the Belgians. The yacht, which has been lying at the Erie Basin, is a large sea-going vessel, luxuriously fitted up. She is a squat-looking boat, however, and is fitted with a rig disproportionately small for the size of the hull.

A table of the number of cabin and steerage passengers landed at the port of New York by the transatlantic steamship lines, prepared by W. C. Moore, landing agent at the Barge Office, shows: The Cunard Line, in 61 trips, carried 15,196 cabin and 17,303 steerage; the North German Lloyd, in 112 trips, carried 12,589 cabin and 25,542 steerage; the American Line, in 53 trips, carried 14,443 cabin and 11,322 steerage; the White Star Line, in 53 trips, carried 10,104 cabin and 19,271 steerage; the Hamburg-American, in 88 trips, carried 10,556 cabin and 15,270 steerage; the French line, in 52 trips, carried 6,044 cabin and 14,264 steerage, and the Anchor Line, in 40 trips, carried 6,450 cabin and 4,400 steerage. The other lines ranged variously, from a total for the Holland-American, for all classes, of 11,468, to the Bordeaux Line, with a total of 960 passengers.

Arrangements were made for the establishment of a regular steamship line from New York to ports in China and Japan, via the Suez Canal. Several steamships averaging about 5,000 tons have been chartered for the service. The ports of call will be Singapore, Hong Kong, Shanghai, Kobe, Yokohama and Rea Sea ports. While steamers are now leaving New York with more or less regularity for these ports they are chartered for the outward trip only, so that this new line will be the first regular steamship line to the far East from New York. Funch, Edye & Co. will be the New York agents. General cargoes will be carried.

Another screw propelled ferryboat is to be built by the Pennsylvania Ferry Co. for the Twenty-third street service in the North River, New York. The contract was signed with John B. Roach, at whose yard in Chester the new boat will be constructed. The ferryboat will be 206 ft. long, of steel, with twin engines driving four screws, two at the bow and two at the stern. The boiler equipment will consist of four Thornycroft water-tube boilers. The boat will be double decked and finely finished; in fact, a counterpart of the vessel recently built at Philadelphia for this route.

The Port Arthur and Mexican Steamship Co. was incorporated for the purpose of running steamers from Port Arthur to the Mexican ports of Tampico, Vera Cruz and Progreso, in connection with the Kansas City, Pittsburg and Gulf Railroad, running between Kansas City and Port Arthur. The Themis, carrying about 2,600 tons and having passenger accommodation for about ten persons, has been chartered, and the steamship company is negotiating for a second vessel of about equal dimensions, so as to have semi-monthly sailings. Steamer wil commence running about the middle of March.

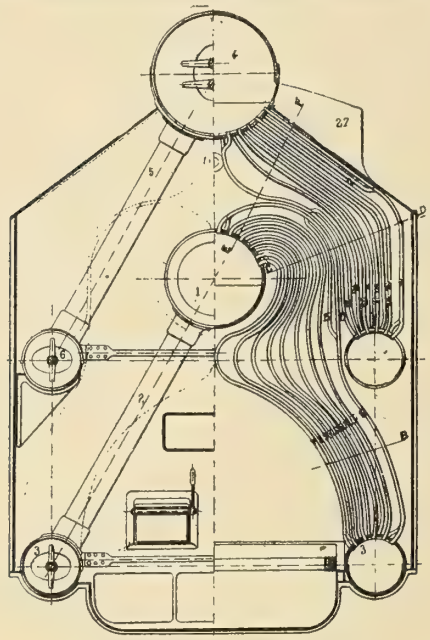
Alterations were commenced in the machinery equipment of the lake steamers Owego and Chemung. These large boats originally had six boilers capable of collectively furnishing steam for 3,000 horse power, or sufficient to run the vessels at 16 miles an hour loaded. This was a higher speed, however, than the conditions of business made necessary, and so the ships are at the Union Dry Dock in Buffalo to have their boiler power cut in half. Three boilers will be left in each, though rearranged as to position, and this will bring the speed down to about 12 miles an hour, and the consumption of fuel very considerably. Less crew also will be needed, and the owners expect to hold their own in the freight business by these alterations. Structural changes will also be made in the boats, so that they can carry iron ore as well as package freight, for which latter they were originally designed and built.

An unusual sight was the presence of two of the largest steamships in the world in New York harbor at the same time, both having made maiden voyages. One of these was the Cymric, the gigantic freight and passenger steamer of the White Star Line, just out from the yards of Harland & Wolff, the builders, at Belfast. She is a new departure for the transatlantic trade of the White Star Line, being of the intermediate class, with great cargo space, large accommodation for a few passengers, and moderate speed. Her dimensions are: Length, over all, 600 ft.; beam, 64 ft., and depth, 42 ft. Her gross tonnage is 12,551 tons. Her speed during the run out from Liverpool averaged 11.53 knots. There was a heavy fog during the last days of the trip or she would probably have made better time. The other vessel was the Pretoria, of the Hamburg-American Line, a German built sister ship to the Pennsylvania, which was illustrated and described in our issue of April, 1897.

SELECTED PATENTS.

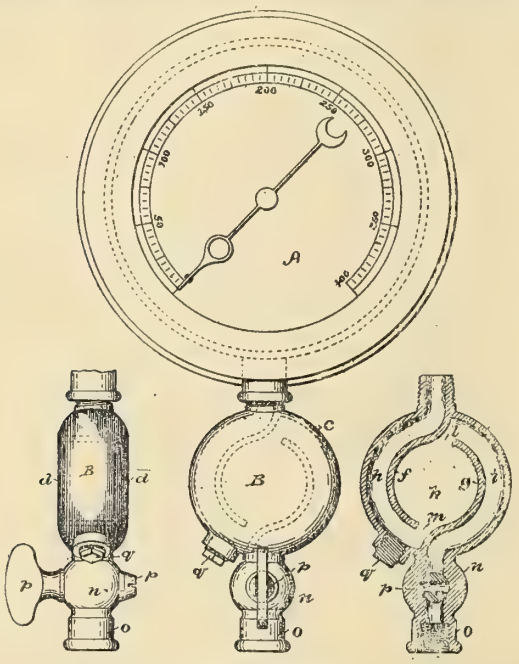
596,865. STEAM-GENERATOR. *Charles Ferrand, Paris, France. Filed July 17, 1897.*

A steam-generator comprising two multitubular boilers each composed of an upper collector and two



FERRAND WATER-TUBE BOILER.

lower collectors, the collectors being connected by water-tubes forming fire-screens, one of the boilers being arranged above the other and both having a common grate, the boilers having separate and independent water-inlets and steam-outlets, the arrange-



ALMY STEAM GAUGE.

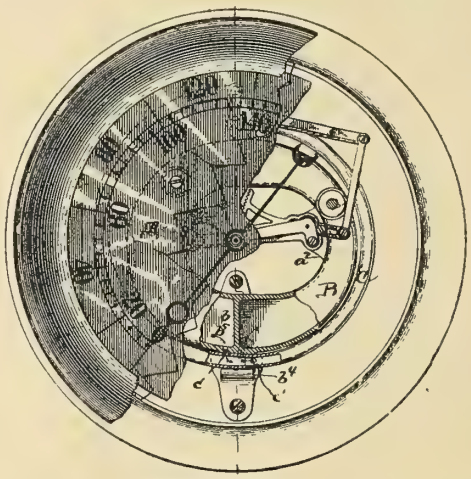
ment being such that the escaping flames and hot products of combustion after first heating the lower boiler operate to heat the upper boiler. A steam-generator composed of two multitubular boilers, the system of tubes of the lower boiler being formed by four groups of tubes, crossing each other and constituting the sides of the combustion-chamber; this arrangement being especially suitable for distributing the heating effect resulting from the direct contact with the fire and less apt to rapidly cool the hot gases from the furnace.

596,674. PRESSURE-GAUGE. *Charles B. Bosworth, Everett, and Joshua H. Millett, Malden, Mass., assignors to the Crosby Steam Gauge and Valve Company, Boston, Mass. Filed January, 24, 1896.*

In a pressure-gauge the combination of a Bourdon spring, with a water-chamber entirely located within the curve of the spring. The combination of the water-chamber and a Bourdon spring arranged one within the other and having a water-passage connecting the two, the water-chamber being provided with a boss or extension, such boss being provided with a passage leading into the water-chamber and a passage leading from the Bourdon tube.

595,844. STEAM-GAUGE. *Darwin Almy and Frank D. Almy, Providence, R. I. Filed January 19, 1897.*

The combination with a steam-gauge, of a hollow shell, of approximately circular form, having two oppositely-disposed openings, and partitions, dividing the interior into the passages *i* and *u*, extending along the outer periphery of the shell and the central circular space *k*, whereby the water of condensation is



CROSBY STEAM GAUGE.

collected in the central space, the channel connecting with the gauge connects with the central water-space at the lowest part of the shell and the steam acts on the water in the central space at the highest part of the shell, as described.

BOOK NOTICES.

High Pressure Hydraulic Fittings, manufactured under Folly's patents, are described in a neat little pamphlet of 85 pages issued by the Tight Joint Co., 159 Bank street, New York. It also contains information for use in designing hydraulic plants of a very valuable character. In the first section of the pamphlet the sizes of the joints carried in stock, with sectional sketches, are given. This is followed by convenient tables of circumferences, areas, squares, etc., for ready reference, and then come a number of pages of hydraulic memoranda with working formulæ. Hydraulic Pressure Transmission is discussed in the closing chapter, which covers many practical points concerning pumps, accumulators, valves and connections, and hydraulic machinery, such as presses, shears and punches. The little book, which is edited by John Platt, M.E., is really a most convenient manual, and represents very effectively the power of compression—getting much into small compass.

Mechanical Draft, a practical treatise, is a well chosen title for a 385 page book issued by the B. F. Sturtevant Co., the well-known manufacturers of blowers of Boston and New York. Its purpose, of course, is to exploit the manufactures of the house, but there is a manifest desire to subordinate this feature of the work to the practical scientific consideration of the subject. It is indeed most timely, for there is now a great awakening to the advantages to be obtained, in the points of economy and convenience, by having means of regulating absolutely the coal consuming capacity of steam generators. The ship so fitted, for example, is independent of weather conditions, and can adjust its consumption of fuel to meet varying demands with a nicety. The work is sufficiently theoretical to interest the studious, and yet not too heavily loaded with disquisitions to discourage the more practical reader. Its simplicity is indeed remarkable. The subject is subdivided into chapters, which cover Water, Steam, Combustion, Fuels and their efficiency; also Efficiency of Steam Boilers, Rate of Combustion, Draft, Chimney and Mechanical Draft, and, finally, an explanation of the various fans manufactured by the company and illustrations of their application. It is a book of real value to the superintending or constructing engineer.

The Arithmetic of the Steam Engine, by E. Sherman Gould, contains, in the words of the author, "the fundamental principles of the steam engine, and the practical calculations based on them." Although styled an arithmetic, its use bespeaks a working knowledge of elementary mathematics, but only to the extent that the subject really demands. It would be a primer to the theoretical physicist, but is a helpful aid for the practical engineer who has aspirations. Brief chapters on Heat and Ice are followed by the division of steam, which treats in turn of Pressure and Volume, Combustion, Efficiency of the Steam Engine, Indicator Diagrams, the Compound Engines, etc. Tables are added, giving properties of Saturated Steam and Hyperbolic Logarithms. D. Van Nostrand & Co., of New York, are the publishers, and $1.00 is the selling price.

Valve Setting Record Book, by P. A. Low, is one of those conveniences which enable the chief engineer to note with exactness the adjustments which are made from time to time in the gear of the modern marine engine, and consequently the resulting changes in efficiency. These, of course, could be noted in any pocket book or on separate sheets. To have a memo. in book form, however, giving all the measurements needed, without the necessity for loss of time and temper in searching for separate records, which are never to be found when wanted, is cheap at the price offered—60 cents. The book has blanks for the data concerning any style of screw engine up to and including a quadruple. Its publishers are Spon and Chamberlain, 12 Cortlandt street, New York.

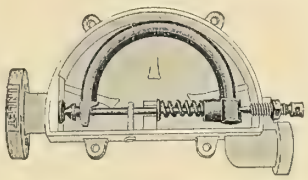
The Marine Review, Cleveland, Ohio, recently issued its annual report of ship building now under way in all parts of the United States. It is a double number, with two 14 in. × 20 in. enameled paper supplements, containing half page illustrations of the officers of the Society of Naval Architects and Marine Engineers, a group of twenty-one ship builders, and a group of marine business men. Views of the principal ship yards of the United States and their products are also shown, together with a reproduction of an oil painting of the Kaiser Wilhelm der Grosse in the original colors. Extra copies can be had by enclosing 20 cents to the Marine Review.

A reference catalogue of the Scientific American Supplement has been received from Munn & Co., publishers, 361 Broadway, New York, which, according to the prefatory note, contains over ten thousand important articles. These cover a field as wide as science itself, and in themselves form a convenient and valuable reference library.

Live Steam

costs money. If wasted for want of a good steam trap—means just that much profit actually burned up in your boiler. Prevent it? Of course you can. Use the "Heintz" Steam Trap on all outlets; saves steam, allows no waste of hot water. You can take a "Heintz" on thirty days' trial—or buy one, use it a year and if not satisfied, return the trap—we return your money. Did we ever return it? No, never asked to; but it has been our guarantee, and we are always ready to meet it.

Booklet "G" will tell our story further, and we would like to send you a copy.

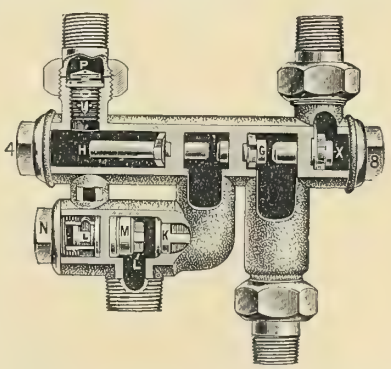


William S. Haines Company,
136 South Fourth Street,
Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 1

THE
PENBERTHY
Special Auto-Positive



INJECTOR.

Working Range, 15—250 lbs. steam.
Handles Hot Water up to 145 degrees.

SEND FOR DESCRIPTIVE CIRCULAR.

PENBERTHY INJECTOR CO.,
115 Seventh St., Detroit, Mich.
BRANCH FACTORY, WINDSOR, ONT.

...Largest Injector Manufacturers in the World...

TRADE PUBLICATIONS.

Pamphlets have been issued regarding the Harthan metallic rod packing manufactured by the Warren Mfg. Specialty Co., Warren, Mass. The packing is illustrated and fully described in this pamphlet.

A fine miniature steel engraving of George Washington was sent out last month by the A. W. Harris Oil Co., Providence, R. I., as a Washington birthday memento. The size of the card was 6 1-2 in. by 7 in. Probably not all the copies are gone yet.

A steel engraving of a four-masted ship is received from Wilcox, Crittenden & Co., Middletown, Conn. It is an exceptionally fine piece of work, 11 in. by 14 in. in size, and is one that every marine engineer who sends for a copy would want to have framed.

Users of steam packing should have a copy of the catalogue issued by the American Steam Packing Co., 60 Federal street, Boston, Mass. It comprises 25 pages and is well indexed. Packings of many makes and for all uses are fully illustrated and described, and there is other information of value to an engineer.

A pocket size catalogue and price list of engineering specialties has been issued by the D'Este & Seeley Co., 29 Haverhill street, Boston, Mass. It comprises 32 pages closely printed, and with each device fully illustrated. Several of the devices are particularly adapted to marine work. Copies of this catalogue should be sent for by all engineers.

A neatly embossed cover makes the centrifugal pump catalogue issued by the Lawrence Machine Co., Lawrence, Mass., unusually attractive. The catalogue comprises 48 pages, printed in two colors. The various types and sizes of pumps manufactured by this company are fully illustrated, and there is much other valuable information for engineers.

The subject of electric heating is fully handled by the catalogue issued by the Consolidated Car-Heating Co., Albany, N. Y. This catalogue illustrates a full line of electric heaters of all types and adapted to all uses and conditions. Because of the large amount of reading matter the subject is thoroughly elucidated and is fully illustrated.

An 1898 pocket calendar has been issued by the Knowlton Packing Co., 19 Pearl street, Boston, Mass. These calendars have much valuable information regarding the subject of packing, postal requirements, etc., in addition to the calendar feature, which extends through the year, and several memorandum pages. Copies of the book can be had upon application.

A very handsome little catalogue is received from th Ingersoll-Sergeant Drill Co., 26 Cortlandt street, New York, regarding the air compressors of various types manufactured by this company. These comprise all sizes, and are suitable for all kinds of work. The catalogue is finely printed on heavy coated paper and has a rich green cover with letters in gold.

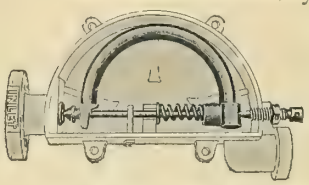
"The Fastest Yacht in the World, the 'Ellide,' Running 40 Miles an Hour," is the brief wording accompanying a picture of this famous boat in running at this speed, and forming a part of a calendar issued by Charles D. Mosher, No. 1 Broadway, New York. On each side of the calendar are pictures, one of an engine and the other of tne Mosher water-tube boiler.

Handsomely printed circulars of electric plants of various types have been published by the New Britain Machine Co., New Britain, Conn., manufacturers of the Case engine. In these circulars different makes of electrical apparatus are illustrated, direct connected or belted to this engine. Engineers who have to do with electric plants will find these circulars of interest.

Labor or Steam

wasted in your plant? Suppose you had a hundred men on your pay roll, and fifteen to thirty doing nothing—"air punchers"—how long before you would weed them out? Yet, that's your proportion of loss in power when you run a plant without the "Heintz" Steam Trap.

Automatic, silent, economical, lasts a lifetime. Only six parts besides the case—can't wear out. No levers, floats, air valves or theories—just plain mechanics. Sent on thirty days' trial on request. Booklet "G" will finish the story. Want it?



William S. Haines Company,

136 South Fourth Street, Philadelphia.

"The Heintz—the best—tho' it has imitators."

21 COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. B

VALVES

Of all kinds for automatically controlling Steam, Water and Air Pressures.

SEND US YOUR PROBLEMS.

Mason Regulator Co., Boston, Mass.

ANTI-FRICTION METAL.

Especially adapted for **HEAVY AND HIGH SPEED ENGINE BEARINGS AND ALL KINDS OF MARINE WORK.**

Outwears, runs cooler and with less lubrication than any babbitt or anti-friction metal made.

Descriptive Circular, Testimonials and Samples Free.

All Kinds of Superior Brass, Bronze, Copper and Non-corrosive White Metal Castings

FENTON & CO., SELLING AGENTS,
39 Cortlandt St., New York.

MARINE ENGINEERING.

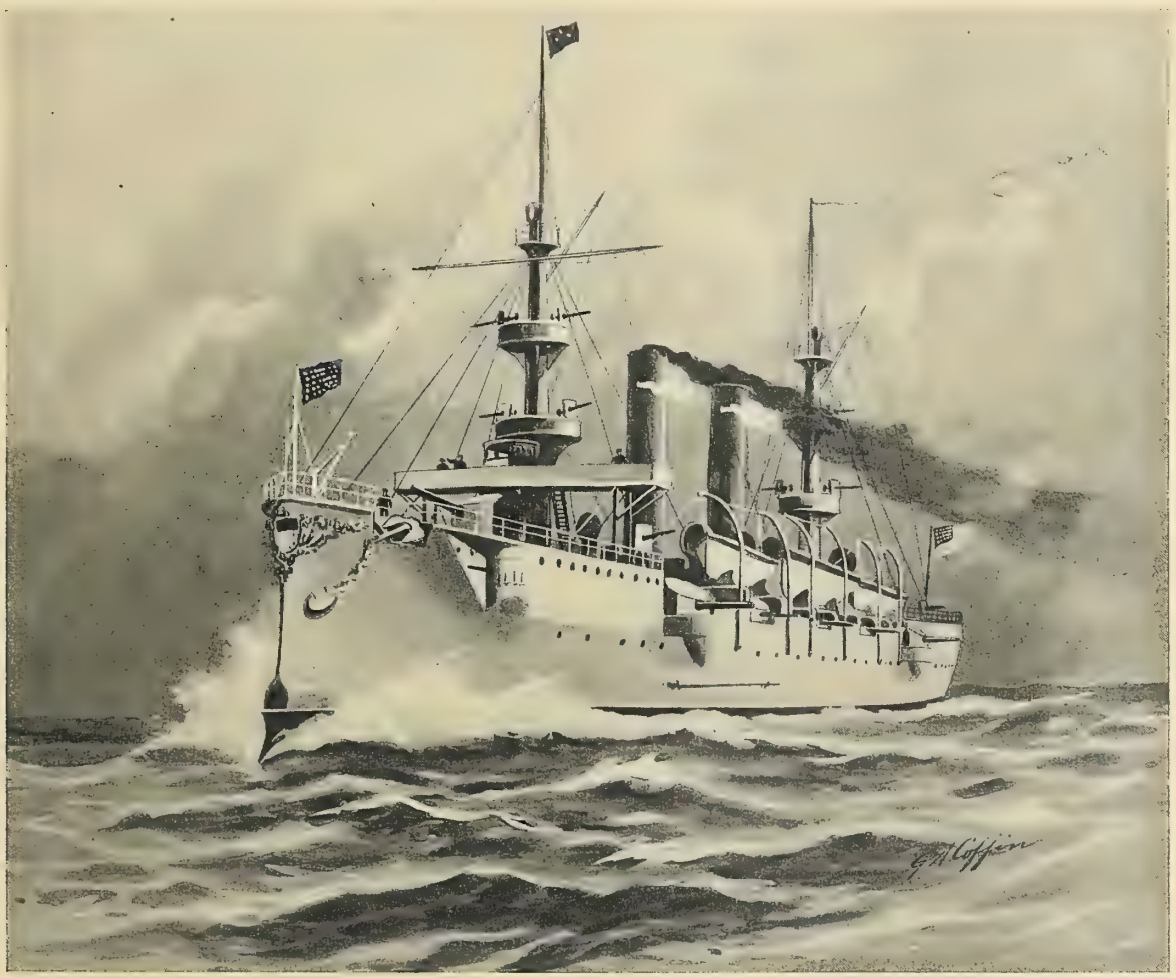
Vol. 2. NEW YORK, APRIL, 1898. No. 4

APR 15 1898
U. S. PATENT OFFICE

PURCHASE OF THE BRAZILIAN CRUISERS AMAZONAS AND ABROUILL BY U. S.

During the past month there have been added to our navy two vessels, the "Amazonas" and the "Abrouill," built abroad for the Brazilian Navy. The "Abrouill" has appeared in print under about a half dozen different aliases, among them the "Admiral Breu." Among so many it is difficult to choose, but "Abrouill" seems to have the support of the best authority.

These two are the second and third respectively of three ships built by Sir W. G. Armstrong, Whitworth & Company at their Elswick yard, Newcastle-on-Tyne. The first of the three, the "Barroso," was launched on Tuesday, August 25, 1896, and completed her trials April 30, 1897. The "Amazonas," the second sister, was launched on Friday, December 4, 1896. The three ships are built of steel, sheathed with teak, and coppered. The "Amazonas" and the "Abrouill" will, therefore, be the first sheathed ships in our navy.



U.S. PROTECTED CRUISER NEW ORLEANS LATELY BRAZILIAN CRUISER AMAZONAS.

Copyright, 1898, by Marine Publishing Co., New York.

The "Wheeling," the "Marietta," and other small gun boats, however, are composite and coppered. The dimensions of the "Amazonas" are as follows: Length, 330 ft.; beam, 43 ft. 9 in.; mean draught, 16 ft. 10 in.; disp., 3,450 tons.

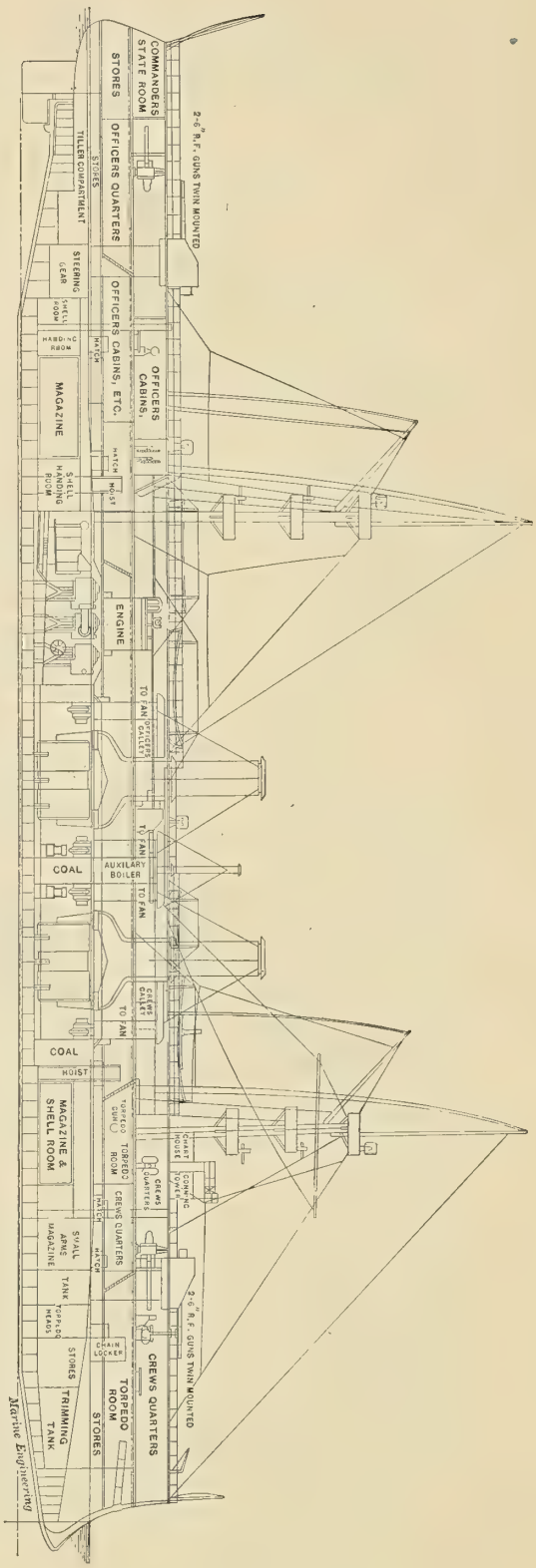
The "Amazonas" comes under the class of protected cruisers. Her only armor is 4 1-2 in. of steel on the gun positions, and a curved steel protected deck extending over her whole length about the water line. The deck is 1 1-4 in. thick on the flat, and 2 1-2 in. thick on the slopes. There is the usual coal protection, her side bunkers covering and enclosing the vitals and extending to 6 ft. above the water line. Experiments show 1 ft. of coal to be about equal to 1 in. of wrought iron armor, or 1-2 in. of the present steel armor.

The armament of the "Amazonas" consists of six 6-in. and four 4.7-in. Armstrong quick-firers, ten 6-pounders and four 1-pounder Nordenfeldts, four Maxims, two field guns and three torpedo tubes. She is able to concentrate a remarkably large proportion of her battery in any given direction. Two of the 6-in. guns are mounted as bow chasers and two as stern chasers. The other two are in the waist, one in each broadside. Each pair of chasers is mounted as twins, so that the two guns train together. Each pair has an arc of fire of 270°, 135° on each side of the fore and aft line. The 6-in. broadside guns can fire from dead-ahead to dead-astern. By this means the "Amazonas" can fire five of her 6-in. guns on either broadside, and four ahead or astern. In addition three of the 4.7-in. guns can fire on each broadside.

With reference to the armament of the "Amazonas" and the "Abrouill," the table on page 3 on Elswick ordnance was issued by the manufacturers last year.

No metallic cartridge is used with the 8-in. quick-fire guns of this table. The makers claim for the 1-pounders of the "Amazonas" and "Abrouill" a muzzle velocity of 2,300 ft. per second, making them superior even to that type of gun of the comparative table. The guns of both cruisers are in all respects the best modern type and highly efficient.

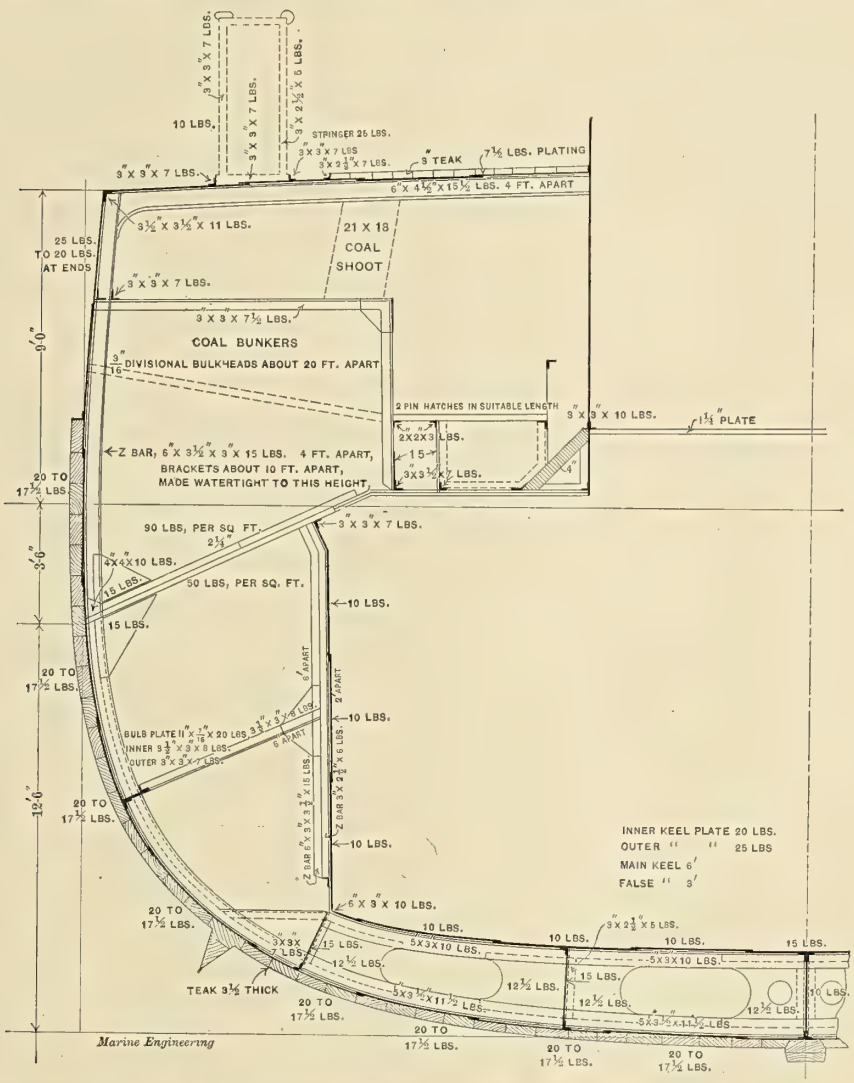
The 4.7 in. is a new caliber to our navy, and up to the time of the purchase of these vessels the navy had no ammunition of that caliber. According to the offer made to the Navy Department by the makers, both cruisers when delivered, were to have on board a full supply of all necessaries, except provisions and consumable stores. The articles thus to be furnished by the contractors include torpedo tubes, torpedo gear, and a full supply of ammunition except torpedoes. Besides, it is expected that more ammunition for the 4.7-in. guns will be bought abroad, and it is also understood that an American firm has agreed to furnish it. Should it after all be found impossible to supply the 4.7-in. guns with ammunition, they will be removed and replaced by the regular navy 5-in. rapid-fire guns, of which there are on hand



LONGITUDINAL SECTION OF THE U.S. TWIN-SCREW WOOD-SHEATHED STEEL PROTECTED CRUISER NEW ORLEANS.

COMPARATIVE TABLE OF ELSWICK RAPID-FIRE GUNS.

Type of Gun.	Maxim-Nordenfeldt.	Maxim-Nordenfeldt.	Field and Naval.	Elswick Quick-Fire.	Elswick Quick-Fire.	Elswick Quick-Fire.	Elswick Quick-Fire.
Bore	1.46 in.	2.2 in.	3 in.	3 in.	4.7 in.	6 in.	8 in.
Length of bore (calibers)	29.9	42.3	28	40	48.9	50	44.6
Length of gun (calibers)	....	....	29.2	42	50	51.4	46.3
Weight of gun	458 lb.	700 lb.	7.5 cwt.	12 cwt.	55 cwt.	7.6 tons	19.9 t ns
Weight of projectile	1 lb.	6 lb.	12.5 lb.	12.5 lb.	45 lb.	100 lb.	210 lb.
Weight of charge	1 oz , 96 gr.	12.5 oz.	13.5 oz.	1.62 lb.	8.4 lb.	19 5 lb.	46 lb.
Muzzle velocity (feet per second)	1,800	2,300	1,585	2,200	2,630	2,612	2,650
Velocity at 2,500 yards (feet per second)	600	1,060	904	1,084	1,564	1,506	1,918
Muzzle energy	22.5 ft. tons	220 ft. tons	217.8 ft. tons	419.5 ft. tons	2,158 ft. tons	4,840 ft. tons	10,226 ft. tons
Energy at 2,500 yards	....	46.7 ft. tons	70.8 ft. tons	102 ft. tons	763 ft. tons	2,262 ft. tons	5,357 ft. tons
Penetration at muzzle	2.2 in.	7.2 in.	4.9 in.	8.1 in.	15.7 in.	21.2 in.	26.1 in.
Rounds per minute	250	28	20	20	10	7	4


3" X 3" X 7 LBS.
10 LBS.
STRINGER 25 LBS.
3" TEAK
7½ LBS. PLATING
6" X 4½" X 15½ LBS. 4 FT. APART
3½" X 3½" X 11 LBS.
21 X 18 COAL SHOOT
25 LBS. TO 20 LBS. AT ENDS
COAL BUNKERS
DIVISIONAL BULKHEADS ABOUT 20 FT. APART
2 PIN HATCHES IN SUITABLE LENGTH
3" X 3" X 10 LBS.
1¼" PLATE
Z BAR, 6" X 3½" X 3" X 15 LBS. 4 FT. APART, BRACKETS ABOUT 10 FT. APART, MADE WATERTIGHT TO THIS HEIGHT
20 TO 17½ LBS.
90 LBS. PER SQ. FT.
50 LBS. PER SQ. FT.
15 LBS.
BULB PLATE
INNER
OUTER
INNER KEEL PLATE 20 LBS.
OUTER " " 25 LBS
MAIN KEEL 6'
FALSE " 3'
TEAK 3½ THICK
Marine Engineering

HALF CROSS-SECTION OF U.S. WOOD-SHEATHED STEEL PROTECTED CRUISER NEW ORLEANS.

numerous complete guns, provided for the auxiliary fleet.

It is believed that the American 6-in. projectiles, which are of ordinary use in our service, will fit the 6-in. guns of the Brazilian cruisers; and the same may be true of the 6-pounders. Their 1-pounders will probably have to be supplied with English ammunition. It has been stated in the daily press that the Navy Department, having acquired some 4.7-in. guns with these cruisers, would proceed to buy more guns of the same caliber abroad; but in fact the department has not bought any rapid-fire guns abroad and does not intend to buy any.

On the subject of ammunition, it may be added that in our navy the only high explosive regularly employed is gun-cotton, and that only in the torpedoes. The Navy Department is experi-

menting with jovite as a bursting charge for shells, but it has so far been used with large calibers only, and the whole matter is yet in an experimental stage.

The "Amazonas" has twin screws, each driven by one vertical inverted triple-expansion engine of the usual marine type, to give 3,750 I. H. P. The estimated speed is 20 knots to 20.25 knots. The coal consumption at full power is 1 kilogram (2.2 lbs.) per I. H. P. per hour. The normal coal supply is 700 tons; and the total 850 tons, giving her a steaming radius of 8,000 knots at 10 knots speed. At the time of going to press positive information as to the character of the "Amazonas's" boilers cannot be had. Thomas F. Lane, who represented the Armstrongs on this side in the transactions with the Government, says they are probably Bellevilles.

The "Amazonas" has had her acceptance trials for the Brazilian Government, but no data on the subject are obtainable. The "Barroso," however, completed her trials on April 30, 1897. She made a six hours' natural draft and four hours' forced draft trial. Under natural draft her mean speed was 19.5 knots; and under forced draft, 20.5 knots. On each trial she exceeded the contract speed by half a knot.

The owners offer, moreover, that both cruisers shall fulfil the British Admiralty's acceptance tests before acceptance by the United States, including stability tests and firing trials to test the resistance of the hull to firing shocks, to be made at the expense of the builders.

All materials employed in the vessels both for hull and machinery is of the highest quality, being in accordance with the specifications used by the British admiralty in the construction of British warships, and the workmanship is of the best. The contractors offer to make tests of workmanship and material according to the practice of the British admiralty, at their own expense. The United States is to be allowed to have small changes made to the extent of making the vessels like the British naval vessels of the same type, provided the cost of the ships is not thereby increased. The contractors also offered to repair, at their own expense, defects due to faulty construction or material discovered in a year.

The full complement of the "Amazonas" is 300 officers and men. The Armstrongs offered to put a navigating crew aboard and deliver her in any port designated by the United States; but instead the U. S. S. San Francisco was sent from Lisbon to Gravesend, England, to take possession of her, and she was accordingly delivered to the United States at Gravesend on March 18. The simple ceremony by which a vessel of war was then peaceably transferred from the flag of one country to that of another in the port of a third is said to be unique in naval history. Lieutenant Commander A. P. Nazro, U. S. N. executive officer of the "San Francisco" took command of the "Amazonas" and with a small crew, also drafted from the "San Francisco," will bring her across. It is expected that she will come under her own steam and in company with the "San Francisco."

There seems to be a disposition on the part of both the Navy Department and the Armstrongs to keep secret the price paid for these ships. It is known, however, that on March 17, a Treasury warrant was drawn for $1,689,621 in full payment for the "Amazonas" and part payment for the "Abrouill." The most reliable reports place the price for both at something over $2,500,000.

The "Abrouill" is a duplicate of the "Amazonas." She has been launched, but is not yet completed. She can be finished in a few months; just how soon is not known, but she is far enough advanced so that she can be towed over, and it is probable that she will be brought across at once in this way.

The "Amazonas" and her sister ship somewhat resemble our "Cincinnati" and "Raleigh." The points of resemblance and difference are best shown in the following table:

COMPARISON OF CRUISERS, CINCINNATI—AMAZONAS.

	"Cincinnati."	"Amazonas."
Hull material	Steel	Steel, sheathed and coppered
Normal displacement	3,213 tons	3,450 tons
Length on water line	300 ft.	330 ft.
Beam, extreme	42 ft.	43 ft. 9 in.
Mean draught	18 ft.	16 ft. 10 in.
Maximum i. h. p. (estimated)	10,000	7,500
Maximum speed (estimated)	19 knots	20 knots
Normal coal supply	350 tons	700 tons
Total bunker capacity	460 tons	850 tons
Steaming radius at 10 knots	3,000 knots	8,000 knots
Protective deck { slopes	2½ in	3 in.
complete, { flat	1 in.	1¼ in.
Armor on gun positions	4 in.	4.5 in.
Torpedo tubes	2	3
Batteries	10 5-in. rapid fire 1 6-in. B. L. R. (bow chaser) 8 6-pounders rapid fire 2 1-pounders rapid fire 2 Colt guns	6 6-in. rapid fire 4 4.7-in. rapid fire 10 6-pounders, rapid fire 4 1-pounders, rapid fire 4 Maxims 2 field guns
Total muzzle energy per min.	175,268 foot tons	231,896 foot tons
Weight of discharge per min.	4,980 lbs.	5,040 lbs.

In addition to these protective decks the "Cincinnati" and "Raleigh" have a cofferdam worked along the water line just above the protective deck and filled with cellulose and other water excluding material.

The above table shows in a striking manner the remarkable strides made in naval construction in the last few years. When the "Cincinnati" and "Raleigh" were designed naval architects abroad regarded the claims made for them by Americans as to speed, protection and battery, as impossible of realization on their displacement and horse power. Yet now, when these ships have been in commission only three years and a half, we see them surpassed on every point, as shown by the above table, by vessels of practically the same displacement and of markedly less horse power. The fact that the ten-knot steaming radius of the later ships is more than double that of the earlier ones is remarkable.

Negotiations for Other Foreign Ships.

At the time of going to press the Navy Department is reported to be negotiating for the Italian "Varese," the Brazilian "Tupy" and the Argentine "San Martino." The "Tupy" is a torpedo gunboat, one of three sisters built by the Germania Co., Kiel, Germany. She was launched on November 15, 1896. She is 259.1 ft. long; 30.84 ft. beam; 10.17 ft. draught, and 1,014 tons displacement. Her armament is two 4.13 in., six 2.24 in., and four 1.46 in. rapid-fire guns, and three 17.72 in. torpedo tubes. One tube is in the bow and two are on deck. She is propelled by two triple-expansion engines, guaranteed to develop 5,918 I. H. P. under forced draft. The contract full speed is 23 knots. Her boilers are of the locomotive type and five in number. She is now about six months from completion.

Italy has started three "Vareses," all sisters. The first was sold to Spain; the second to Argentina and is the "San Martino" above mentioned.

The "San Martino" and the "Varese" are from the Orlando Bros., of Leghorn. They are armored cruisers of the following dimensions: Length, 328 ft.; beam, 58 ft. 8 in.; maximum draught, 24 ft.; displacement, 6,840 tons. Each has a belt of Harveyized nickel steel 8 ft. 3 in. wide along the water line, throughout the whole length. The belt armor has a maximum thickness of 6 in. tapering to 3 in. Above the belt armor is an armored central citadel of about two-thirds of the length of the vessel. The citadel armor is of Harveyized steel, 6 in. thick. The gun barbettes are 6 in. thick, and their bases are protected by athwartship armor bulkheads 6 in. thick. The broadside battery of 6 in. rapid fire guns is covered by an armor deck 1.9 in. thick. The protective deck is .8 in. thick behind the heavy armor amidships, and 1.45 in. thick at the ends. There is an armored conning tower 6 in. thick. The armament consists of two 10-in. rifles and ten 6-in. and six 4.7-in. rapid fire rifles, ten 6-pounders, ten 1-pounders, two Maxims and four torpedo tubes. They have twin screws, each driven by one triple expansion engine of 6,500 I. H. P. The estimated speed is 20 knots. The coal capacity is 1,000 tons and the complement 470. According to reliable reports these vessels cost $3,656,500 each.

Auxiliary Ships for the Navy.

The intention of the Government to increase the fighting naval forces in the event of hostilities by the addition of armed mercantile cruisers has caused much speculation as to the ships which would be selected. An authoritative statement concerning this matter has appeared in a recent issue of the Army and Navy Journal which we here reprint:

Secretary Long has appointed a board to secure auxiliary ships for the navy, composed of Captain Frederick Rodgers, Chief Engineer A. F. Dixon, Naval Constructor J. G. Tawresey and Lieutenant Nathan Sargent, recorder. The board has been conducting its investigations in New York. The only vessel purchased thus far is the steam yacht Mayflower, built for Ogden Goelet. She was purchased last January by King Leopold, of Belgium, but for some reason was not taken abroad and was given into the hands of our government for a consideration of $430,000, and will be converted into a torpedo gunboat. The Mayflower is one of the largest and most completely finished pleasure vessels ever constructed for an American yachtsman. She is 275 ft. on the water line, 321 ft. from fiddlehead to taffrail, 36 ft. 6 in. beam, 30 ft. deep to the bridge deck at side, and draws 17 ft. 6 in. of water. Her rig is that of a brigantine, with fidded topmasts and jibboom, and she carries nine small boats, including a 32-ft. steam launch, two life- She can also pick up two 1-2 raters, if occasion should boats, three dingies, cutter, gig and electric launch. require. The yacht is divided by steel bulkheads into nine separate compartments, and is designed to float even if any two of these should be filled simultaneously with water. With a coal capacity of 530 tons, the Mayflower can steam more than 2,000 knots at full speed, or 6,000 knots at a speed of 12 knots. Two of the cylinders of her engines are 22½ in. in diameter, two of 38 in. and four of 40 in. and the stroke is of 27 in. The armament consists of two 3-pounders, two 1-pounders and two Colt's machine guns. It is proposed to substitute for the Mayflower's battery a more effective one, consisting of 4-inch, 6-pounder and 1-pounder rapid-firing guns and 2 torpedo tubes. The board is considering the purchase of other yachts and tugs for conversion into vessels of war. Sixty-three vessels have been placed at the disposal of the board for examination. Three are the American liners St. Paul, 11,629 tons; St. Louis, 11,629 tons; Paris, 10,668 tons; New York, 10,674 tons. The proposed armament for these is two 6-inch, ten 5-inch, ten 6-pounder and six 1-pounder guns. Six others are: El Rio, 4,664 tons; El Sud, 4,659 tons, El Norte, 4,659 tons; El Sol, 4,522 tons; Vigilancia, 4,115 tons; Seguranca, 4,033 tons. These can carry each eight 5-inch, four to six 6-pounder and two to four 1-pounder guns. Fifteen others are vessels of from 3,000 to 4,000 tons; thirty are of from 2,328 to 2,982 tons, and four from 1,503 to 1,892 tons. They will carry six 5-inch or 4-inch, four to six 5-pounder and two 1-pounder guns. The San Juan, 2,076 tons; San Blas, 2,075 tons, and Manhattan, 2,080 tons can each carry four 5-inch, four 6-pounder and two 1-pounder guns. This would make a total armament for all of these vessels, if they were accepted, of eight 6-inch, 208 5-inch, 139 4-inch, 216 6-pounder, 114 5-pounder and 158 1-pounder guns; in all 913 guns on 63 vessels, aggregating 208,691 tons.

In addition to the above alterations to the "Mayflower," her side plating will be reinforced from about 2 ft. below the water line to about 5 ft. above it, to a thickness of 7-8 in., as a protection against small arm fire.

Washington advices report other vessels acquired by the government including the yachts Columbia, Hermione, Almy and Alicia, and the tugboats DeWitt C. Ivins, P. H. Wise, Walter A. Luckenbach, Winthrop, El Toro, Hercules and Atlas; these to be renamed and put in charge of naval officers as follows: "Hermione" to "Wasp," Lt. Ward; "Almy" to "Eagle," Lt. Southerland; "Alicia" to "Hornet," Lt. Helm; "Luckenbach" to "Uncas," Lt. Brainard; "Winthrop" to "Osceola," Lt. Purcell; "Wise" to "Sioux," Ensign Gherardi; "El Toro" to "Algonquin," Ensign Crosley. The "Chalmette" of the Morgan Line was surveyed with a view to fitting her out as a fleet repair ship.

Congressional Shipbuilding Program.

Legislation for the construction of new vessels for the navy is still in embryo. The House Naval Committee has decided to recommend three new battleships, six torpedo boats, and six torpedo boat destroyers. The Senate has passed an appropriation of $260,000 for a new gunboat to take the place of the old sidewheel "Michigan" on the Lakes.

The Senate has also passed an appropriation for eight new vessels for the Revenue Cutter service, as follows: One to take the place of the revenue steamer Seward, cost not to exceed $160,000; one to take the place of the revenue steamer McLane, cost not to exceed $160,000; one to take the place of the revenue steamer Colfax, cost not to exceed $160,000; one to take the place of the revenue steamer Boutwell, cost not to exceed $160,000; one for service on and in the vicinity of the Columbian River Bar, Pacific coast, cost not to exceed $250,000; one for harbor service at Philadelphia, Pa., to replace the revenue steamer Washington, cost not to exceed $45,000; one for harbor service at Boston, Mass., to replace the revenue steamer Hamlin, cost not to exceed $45,000; one for harbor service at New York, to replace the revenue steamer Chandler, cost not to exceed $45,000.

Designs are being prepared for the cutter for the Columbia river, which will be of the following dimensions: Length, 170 ft.; beam, 29 1-2 ft.; depth of hold, 15 ft.; draught, 8 ft.; displacement, 650 tons.

Proposed New Dock Facilities.

The general activity in naval circles has revived interest in the matter of dry docks. Last summer the Secretary of the Navy appointed a Board of naval officers, whose senior member was Commodore F. M. Bunce, U. S. N., to consider the subject of dry docks required by the Government. To avoid threshing over old straw we repeat here only the Board's summary of its own report in the tables on this page.

In addition the Board recommended that separate systems of docking should be provided for torpedo and other small vessels of a size in porportion to these classes.

Docks Urgently Needed.

	Time Needed for Construction.	Cost.
Boston: Concrete dock 750 ft. long..	2 years	$1,350,000
New York: Concrete dock 500 ft. long	2 years	1,200,000
Norfolk: Concrete dock 500 ft. long (alternate to Newport News)....	2 years	1,100,000
Lengthening present stone dock with concrete 150 ft.....	1 year	160,000
Port Royal: Construction of wharf and slightly widening lower alters of dock.....	6 months	75,000
New Orleans: (Algiers) Steel floating dock, moorings and wharf.....	10 months	750,000
Mare Island: Concrete dock 500 ft. long	2 years	1,100,000
		$5,735,000

With reference to the dock for New Orleans the Board reported as follows:

This dock should be capable of lifting a vessel of 15,000 tons displacement and 27 ft. draught of water. It is recommended that a wharf be built along the water front of the government reservation at Algiers, to be an adjunct to the dock. The latter will be moored and will operate in deep water off shore, and when a vessel is lifted dock and ship can be hauled together alongside the wharf and the ship be easily accessible to workmen from the naval station. A steel floating dock is selected for this situation for the following reasons:

(1.) Changes in water level from high and low river do not affect its operation. [The usual differences between high and low river at New Orleans is about 16 ft.]

(2.) It is located in fresh water and expense of maintenance will be small.

(3.) Great depth of water within mooring distance of wharf.

(4.) Rapidity with which a floating dock can be constructed to meet the urgent need for a dock on the Gulf of Mexico.

The Secretary of the Navy requested from Congress legislation on the lines of the Bunce Board's report. The Senate Naval Committee has not yet acted on the matter. The House Naval Committee just reported in favor of dry docks as follows:

One at Portsmouth, N. H., of stone or concrete, not less than 500 ft. long.

One at Boston of timber, 750 ft. long.

One at League Island, Philadelphia, of timber, 750 ft. long.

One at New Orleans of steel, floating, capable of docking a ship of 15,000 tons.

One at Mare Island, California, of timber, 500 ft. long.

All the above docks are to have 30 ft. of water over the sill at mean high tide and are to be of sufficient width to take the largest ships.

To render effective such a dock as is proposed at Mare Island, extensive dredging operations will be necessary, as a draught of water only 22 ft. can now be carried through San Pablo Bay, and only 19 ft. up the Napa river to the Navy Yard. In fact a fleet of dredges has been at work in the Napa river between Vallejo and Mare Island for more than six months.

It is expected that the floating dock for New Orleans if authorized will be made self docking, in sections, probably three.

The failure of the House Naval Committee to

Docks Recommended as Additional, to Place the Docking Facilities of the Country on an Adequate Footing.

	Time Needed for Construction.	Cost.
New London: A fresh-water basin and dock connecting basin with river	2 years	$1,000,000
Newport News: Steel floating dock and moorings (alternate to Norfolk concrete dock).....	10 months	650,000
Tortugas: Steel floating dock and moorings.....	10 months	650,000
San Francisco: Concrete dock on Yerba Buena Island, 750 ft. long.	2 years	1,550,000
San Pedro: Concrete dock 750 ft. long	2 years	1,550,000
		$5,400,000

recommend a dock at Newport News, Va., has been severely criticised in some quarters. On this account the following extract from the Bunce Board's report is of special interest:

The deep and protected waters at the mouth of the James River estuary are regarded by the board as one of the most important positions on the entire coast. In this neighborhood it is essential that there should be a dock capable of taking ships of the largest size, and facilities for making repairs of every character. Were the water approaches of a nature to warrant, the Norfolk Navy Yard would be the proper location for such a dock, but the channel from the open water of Hampton Roads to the Navy Yard is ten miles long through narrow and dredged channels, has a depth of but 25 ft. at low water, and is so narrow that the accidental sinking of any large vessel in it would effectually block the fairway. The board is therefore of the opinion that Norfolk in its present condition is not a proper place for the largest type of dock required by the strategical importance of the location. At Newport News are sufficient water and good conditions generally for a first-class floating dock, and at this place a steel double sided combined floating and graving dock is recommended, unless the channel from Hampton Roads to Norfolk be increased, concurrently with the building of the dock at Norfolk, to a width of 400 ft. and a depth of 30 ft. at mean low water, in which event the recommendation of the board is that the concrete graving dock referred to under Norfolk Navy Yard be constructed. * * * The board, learning that the Newport News Shipbuilding and Dry Dock Co. contemplated building a second dry

CHILIAN ARMORED SHEATHED CRUISER O'HIGGINS—FOR DESCRIPTION SEE PAGE 8.

dock at their works, opened a correspondence with the company, by authority of the department. * * * The president of the company also appeared before the board and stated that in the construction of its dock the company would gladly be governed by the wishes of the department as to its materials, size, character, and would enter into any fair agreement with the department as to its use by the government. The company is also willing to immediately commence the building of a dock and prosecute the work to completion with all possible speed, one year being specified by the president as the probable extreme limit of time required.

C. B. Orcutt, president of the Newport News Shipbuilding and Dry Dock Company, has at this time notified the Navy Department that work would shortly be commenced upon the new dock. It is proposed to make it 900 ft. long and of proportionate beam, and to cost probably $1,000,000.

With reference to Tortugas the Bunce Board reported:

The board recommends that a double sided steel floating and graving dock be located at Tortugas, in the inner harbor, using the natural basin of the entrance of the inner harbor for docking and undocking in case dredging a basin is found to be impracticable during the improvements of the channel, as recommended. Tortugas harbor is selected for the strategical reasons stated in the report of the Gulf Dock Commission, 1891, from its advantageous position in relation to the commerce of all the ports of the Gulf of Mexico, being about equally distant from the principal centers of trade on the Gulf, and from its remarkable advantages as a coaling and supply station for heavy ships * * * Tortugas from its position bears the same relation to the Gulf of Mexico as Gibraltar to the Mediterranean.

At present battleships would have to anchor one quarter mile from Fort Jefferson, Tortugas, and coal from lighters. During the current month, however, a contract has been let for dredging about 300,000 ft. about Fort Jefferson. This will bring the ship channel to a uniform depth of 30 ft. and will enable battleships to coal at the wharves without difficulty. The Alabama Dredging and Jetty Company of Mobile, got the contract at 38 cents per cu. yd. Within the next month two coal houses of 20,000 tons capacity will be erected at Fort Jefferson. Two new coal wharves, and an electric plant for lights, searchlights, and cranes, are also proposed. Altogether the Navy Department will spend more than $500,000 on Tortugas.

The War Department will mount a few modern guns at Fort Jefferson and man them with two batteries of artillery.

About $115,000 will be spent at Key West also, mostly on new coal sheds.

Purchase of War Materiel.

A line on the cost of a modern naval engagement can be had by an inspection of the prices which the Navy Department has agreed to pay for projectiles, to be manufactured by various concerns. The contracts recently made were with the Firth-Sterling Company, the Midvale Company, and the Carpenter Steel Company, all of Pennsylvania, for 13-in. shells $1,100 each, 12-in. shells $1,000, 10-in. shells $850, 6-in. shells $250, 5-in. shells $100, 4-in. shells $96.00. Extensive contracts have also been entered into by the Navy Department with powder manufacturers and cartridge manufacturing concerns, and also for torpedo gear and supplies.

Crusiers O'Higgins and Christobal Colon.

The Chilian cruiser O'Higgins, which was reported as sold to Spain is a product, like the "Amazonas," and the "Abrouill" of the Armstrongs' yard at Elswick. She was launched in May last and is now rapidly approaching completion. The length on the load water line is 412 ft.; beam, 62 ft. 9 in.; displacement, 8,500 tons; and mean draught, 22 ft. Her hull is of steel, sheathed with teak and coppered. Her armament consists of four 8-in., ten 6-in., four 4.7-in., ten 12-pounders, ten 6-pounders, four Maxims, and three torpedo tubes. Her guns are all Elswick quick-firers of the types described in the table given in a preceding article. She has the usual protective deck, which is from 1.5 in. to 2 in. thick. Along the water line for the greater part of her length she has a belt of Harveyized steel 7 ft. wide and 7 in. thick, tapering to 5 in. The turrets and barbettes of the 8-in. guns and the casemates of the 6-in. guns are of nickel steel, 6 in. thick. She has also a conning tower of 9 in. Harveyized steel. From this the voice pipes, engine room telegraphs, and electric call wires pass below through a heavy armored tube. There is the usual coal protection. She has two triple-expansion engines, each in its own watertight compartment, and twin screws. The total I. H. P. is 16,500. The guaranteed speed is 21 1-2 knots. The boilers are Bellevilles. The total coal capacity is 1,200 tons. She is supposed to have cost nearly $5,000,000.

The Italian cruiser Guiseppe Garibaldi lately acquired by the Spanish government and renamed the "Christobal Colon" is a powerful ship of about 6,800 tons. She was built at the Italian yard of Ansaldo & Co. Her dimensions are: Length, 328 ft.; beam, 59 ft. 9 in.; and draught, 23 ft. 3 in. In general appearance she somewhat resembles our "Indiana." Her armament includes two 25cm. breech-loading rifles, placed in end barbettes. Also ten 15cm. guns, five on each broadside, and six 12cm. guns, ten 57mm. guns and ten 37mm. guns of the rapid-fire pattern. She is fitted with twin screws, and engines with cylinders 42 in., 63 in. and 93 in. by 46 in. stroke. The boilers are water-tube, of the Niclausse type. Her indicated horse power on trial with natural draught was 10,670, and her mean speed 19.35 knots. Electricity is extensively used for auxiliary purposes, such as working ammunition hoists, training guns and handling the search lights.

Our thanks are especially due to Thomas F. Lane, the Washington agent of the Maxim Nordenfeldt Guns and Ammunition Co., Ltd., for courtesies.

AMENDMENTS TO THE STEAMBOAT RULES AND REGULATIONS NOW IN FORCE.

At the recent meeting of the Board of Supervising Inspectors of Steam Vessels, held in Washington, a number of amendments to the existing regulations were decided upon. These have been approved by the Secretary of the Treasury and now have the force of law. James A. Dumont, Supervising Inspector General, and President of the Board of Supervising Inspectors has issued the amendments in the form which we here present, with this notation:

"Following is the text of the rules amended in port only, the parts stricken out enclosed in brackets [thus] while the additions to such paragraphs are printed in *italics*. Entirely new sections and paragraphs of sections are in plain type preceded by the word (new) in parenthesis."

AMENDED RULES.

Rule I.

SECTION 3. (Fifth paragraph.)

The sample must show, when tested, an elongation of at least 25 per cent. in a length of 2 inches for thickness up to one-fourth inch, inclusive; in a length of 4 inches, for over one-fourth to seven-sixteenths, inclusive [in a length of 8 inches, for over seven-sixteenths to 1 inch, inclusive; and in a length of 6 inches, for all thickness over 1 inch]; *in a length of 6 inches for all plates over seven-sixteenths inch thickness and under one and three-fourths inches thickness.*

SECTION 6. (First paragraph.)

* * * All steel plate over three-fourths inch thickness, *and less than one and three-fourths inches thickness*, shall show a reduction of not less than [forty (40)] *32.5 per cent.*

Rule II.

SECTION 2. (Second paragraph.)

All boilers built for marine purposes after July 1 [1897] *1898*, shall be required to have all the rivet holes [in the shell] "fairly drilled" instead of punched, and the longitudinal laps of their cylindrical parts double riveted, to be entitled to 20 per cent. additional pressure. [Also that steel plates of one-half inch thickness and over for all boilers shall have all the rivet holes in the shell "fairly drilled" instead of punched.]

SECTION 6. (First paragraph.)

No braces or stays hereafter employed in the construction of boilers shall be allowed a greater strain than six thousand (6,000) pounds per square inch of section, and no solid or hollow screw stay bolt shall be allowed to be used in the construction of marine boilers in which salt water is used to generate steam unless said screw stay bolt is protected by a socket. But such screw stay bolts without socket may be used in staying the fireboxes and furnaces of such boilers and elsewhere when *such screw stay bolts are drilled at each end with a hole not less than one-eighth inch diameter to a depth of at least one-half inch beyond inside surface of sheet*, when fresh water is used for generating steam in said boilers (*to take effect on and after July 1, 1898, on all boilers contracted for or construction commenced on or after that date*). Water used from a surface condenser shall be deemed fresh water. The flat surface at back connection or back end of boilers may be stayed by the use of a tube, the ends of which being expanded in holes in each sheet beaded and further secured by a bolt passing through the tube and secured by a nut. An allowance of steam shall be given from the outside diameter of pipe. For instance, if the pipe used be 1½ inches diameter outside, with a 1¼-inch bolt through it, the allowance will be the same as if a 1½-inch bolt were used in lieu of the pipe and bolt. And no brace or stay bolt used in a marine boiler will be allowed to be placed more than 10½ inches from center to center *to brace flat surfaces* on fireboxes, furnaces, and back connections; nor on these than at a greater distance than will be determined by the following formulas: *Flat surface on heads of boilers may be stiffened with doubling plate, tees, or angles.*

SECTION 6. (Second paragraph.)

The working pressure allowed on flat surfaces fitted with *screw stay bolts riveted over*, screw stay bolts and nuts, or plain bolt with single nut and socket, or riveted head and socket, will be determined by the following rule: * * *

SECTION 6. (Seventh paragraph.)

Flat part of boiler-head plates when braced with bolts having double nuts and a washer at least one-half the thickness of head, where washers are riveted to the outside of head, and of a size equal to seven-eighths of the pitch of stay bolts, or where heads have a stiffening plate, *either on inside or outside*, covering the area braced, will equal the thickness of head and washers. * * *

SECTION 8. (First paragraph.)

8. The following table shall include all riveted and lap-welded flues exceeding 6 inches in diameter and not exceeding 40 inches in diameter, not otherwise provided for by law.

For any flue requiring more pressure than is given in table, the same will be determined by proportion of thickness to any given pressure in table to thickness for pressure required, as per example:

A flue not over 19 inches diameter and 3 feet long requires a thickness of .39 of an inch for 176 lbs. pressure, what thickness would be required for 250 lbs. pressure?

176 : .39 : : 250 : .5539, or a thickness of .554 inch.

Or if .39 inch thickness gives a pressure of 176 lbs., what will .554 inch thickness give?

.39 : 176 : : .554 : 250 lbs. pressure required.

* * *

SECTION 13. Repealed.

[Riveted and lap-welded flues exceeding 6 inches in diameter, and not exceeding 40 inches in diameter, required to carry a working steam pressure per square inch exceeding the maximum steam pressure prescribed for any such flue in the table of section 8 of this rule, shall be constructed under the provisions of section 15 of this rule, and limited to the working steam pressure therein provided for furnace flues; but in no case shall the material in any such riveted or lap-welded flue be of less thickness for any given diameter than the least thickness prescribed, in the aforementioned table, for flues of such diameter.]

SECTION 15. (Third paragraph, page 33, Rules and Regulations, 1897, amended.)

All vertical boiler furnaces constructed of wrought iron or steel plates, and having a diameter of over 42 inches or a height of over 40 inches, and crown sheets of flat-sided furnaces, if made with a radius of over 21 inches, and all cylindrical shells of back connections having a radius of over 21 inches, shall be stayed [with bolts] as provided by Section 6 of Rule II, for flat surfaces: *But the cylindrical shell of bottom of back connections may be stiffened by angles or tees secured with rivets spaced no more than 6 inches from center to center, the distance from center of rivets at edge to center of tee, or from center to center of tees, not to exceed 24 inches, tees and rivets to be of suitable section for the pressure and radius of surface braced.* * *

SECTION 21. (Addition to second paragraph, new.)

Provided, That manhole opening in front head of externally-fired boilers, under the flues, as required by Section 4434, United States Revised Statutes, shall be of dimensions not less than 8 by 12 inches in the clear.

SECTION 38. (Second paragraph, page 42, Rules and Regulations, 1897.)

When holes exceeding 6 inches in diameter are cut in boilers for pipe connections, man and hand hole plates, such holes shall be reinforced, *either on the inside or outside of boiler, with reinforcing plates, which shall be securely riveted to the boiler, rivets spaced as for stay bolts as determined by Section 6, Rule 11, such reinforcing material to be of* [with] wrought-iron or steel rings of sufficient width and thickness of material to equal the amount of material cut from such boilers. * * *

Rule V.

SECTION 1. (New paragraph following first paragraph.)

Mates, assistant engineers, or second-class pilots serving under five-years license, entitled by license to raise of grade, shall have issued to them new licenses for the grade for which they are qualified, the local inspectors to forward to the supervising inspector-general the old license when surrendered, with the report of the circumstances of the case. New licenses may also be issued in the case of license lost by wreck, fire or any other cause, upon a satisfactory showing of such loss to the inspectors, duly sworn to.

SECTION 1. (New paragraphs at end of section.)

Applicants for license as master or pilot of steam vessels of the naval militia, after passing an examination for color blindness, may be examined by the inspectors as to their knowledge of the pilot rules and handling of vessels, and if the applicant be found qualified in the judgment of the inspectors he may be granted a special license as master or pilot on such vessels on the waters of the district in which such license is granted, and for no other purpose.

All licenses issued to officers of the naval militia provided for in the preceding paragraph of this section, or in section 3 of this rule, shall be surrendered upon the party holding it becoming disconnected from the naval militia by resignation or dismissal from such service; and no license shall be issued as above except upon the official recommendation of the chief officer in command of the naval station of the state in which the applicant is serving.

The following classes of engineers are omitted from section:

[Chief engineer of condensing freight, towing and fishing steamers; chief engineer of non-condensing freight, towing and fishing steamers; first assistant engineer of condensing freight, towing and fishing steamers; first assistant engineer of non-condensing freight, towing and fishing steamers; second assistant engineer of condensing freight, towing and fishing steamers; third assistant engineer of condensing freight, towing and fishing steamers.]

SECTION 2. (New paragraph preceding classification of "Second Assistant" engineers.)

Any assistant engineer of ocean steamers of 1,500 gross tons burden and over, having had actual service in that position for one year, may, if the local inspectors in their judgment deem it advisable, have his license endorsed to act as chief engineer on lake, bay, sound or river steamers of 750 gross tons or under.

SECTION 3. (New paragraph.)

Any applicant for license as chief engineer or assistant engineer of steam vessels of the naval militia may be examined by inspectors and granted a special license as such, and for no other purpose, if, in the judgment of the inspectors, he be qualified. [See last paragraph of Section 1 of this rule.]

SECTION 5. (Amended.)

5. No person shall receive an original license as engineer or assistant engineer, except for special license on small pleasure steamers of 10 tons and under, and ferryboats, sawmill boats, pile-drivers, and other nondescript similar small vessels, navigated outside of ports of entry and delivery, who has not served at least three years in the engineer's department of a steam vessel, *a portion of* which experience must have been obtained within [two] *three* years preceding the application.

SECTION 5. (New paragraph at end of section.)

Any person may be licensed as engineer (on Form 2130½) on vessels propelled by gas, fluid, naphtha, or electric motors, of 15 tons gross or over, engaged in commerce, if in the judgment of the inspectors, after due examination in writing, he be found duly qualified to take charge of the machinery of vessels so propelled.

SECTION 6. (New paragraph at end of section.)

Any person owning a pleasure yacht of 15 tons and under, navigated for pleasure only, holding a master or pilot license, is fully authorized to navigate his own pleasure yacht, cruising in the inland waters of the United States, without being required to report to the various boards of inspectors whose districts they may be passing through.

SECTION 10. (Last paragraph.)

[No original first-class pilot license on the Northwestern lakes shall be issued hereafter to any person who has not been licensed and served at least one full season of eight months as second-class pilot on steamers, such service as second-class pilot to have been within two years preceding the application for such license.]

On the Northwestern Lakes and connecting waters, any person holding a second-class pilot license may come before any local board for examination for first-class pilot license, after having served one year as wheelsman, watchman, or as assistant to a first-class pilot on freight, towing, or passenger steamers, such service to have been within two years preceding the application for raise of grade.

SECTION 14. (New paragraph at end of section.)

First-class pilots, who have served as such on the waters of the Atlantic or Pacific coast inland waters, or on the Great Lakes, on steam vessels of 1,000 tons and upward, may have their licenses endorsed for masters of steam vessels of 500 tons and under, on the same waters, without examination, when the inspectors are satisfied of their qualifications therefor.

SECTION 19. (Last paragraph repealed.)

[All examinations for licenses to be made by the board of local inspectors.]

SECTION 8. (Last paragraph.)

And it shall also be the duty of the inspectors to compel all floating structures, such as steam elevators (propelled by their own motive power), to have their whistles located on the front side of such superstructures having an elevation higher than the pilot house of the vessels. [This amendment to take effect July 1, 1897.]

SECTION 8. (New paragraph at end of section.)

All steam whistles shall be placed not less than six feet above the top of the pilot house of steam vessels where the height of the smoke stack will admit the attachment of same below its top, when not hinged for passing under bridges, and it shall be the duty of inspectors to enforce this rule at the annual inspection.

It shall be the duty of all inspectors before granting an original license or renewing an existing one to a master or pilot of steam vessels for any waters, to satisfy themselves by an examination in writing, that such officers are thoroughly familiar with the pilot rules upon the waters for which they are licensed.

Each master and pilot of steam vessels, wherever employed, shall, when receiving his license (either original or renewal), be furnished with a pamphlet copy of the Rules and Regulations governing pilots and of the statutes upon which such rules are founded applicable to the waters on which their licenses are intended to be used as stated in the body thereof.

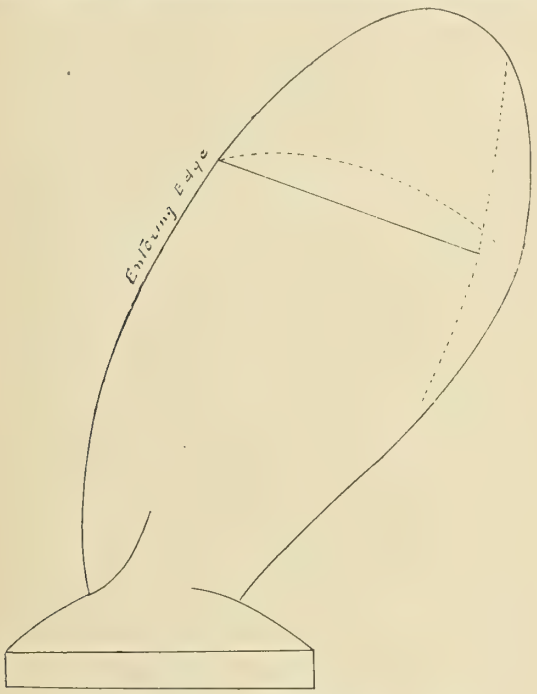
A CURIOUS PHENOMENON IN PROPELLER BLADES WITH SUGGESTION AS TO ITS CAUSE.

BY P.A.E. W. STROTHER SMITH, U.S.N.

During the recent overhauling of the American Line Steamship Paris, at the yard of the Newport News Shipbuilding and Dry Dock Company, the author noticed that a certain portion of the driving face of each one of her propeller blades was being chipped off, and there being strong evidence of method in this seeming madness, an investigation and discussion brought out the following facts and theories:

The propellers of the S.S. Paris have an expanding pitch, and it would not seem strange, perhaps, to alter the face of such a blade, but when the S.S. St. Paul arrived for docking and repairs it was noticed that her blades were chipped and faired about the same amount at the same place.

The propeller of the "St. Paul" is a true screw, bent back from the plane of rotation and the blades are curved radially away from the entering edge on the go-ahead motion. The expanded area is 93 sq. ft., the projected area 70.5 sq. ft., dia. 19 ft. 6 in., and the pitch 27 ft. and 6 in. at 14 ft. dia. The accompanying sketch of one of



BLADE OF PROPELLER OF ST. PAUL.

her blades shows the area faired away and the relative position thereof.

The facts are that for some time, at every period of docking the liners Paris, New York, St. Paul and St. Louis, their propeller blades were chipped and faired at the point shown in the accompanying sketch. It was claimed that this portion of the blade curled in toward the driving face, and in order to keep this face fair and the pitch as designed, it was necessary to chip off a wedge of metal varying from 3 to 4 ft. long at the back of the wedge to from 6 to 8 in. broad. As much as 3-8 in. has been chipped off at the leaving edge of the blade.

It is claimed that this decreases the slip by about 1 1-2 per cent., the same conditions of hull surface and state of wind and sea holding.

How to account for the fact that a metal should bend against a pressure is not an easy thing to do, and were it not on the assurance of good authority that such curling does take place, it would be passed upon as a matter of small importance and not to be believed. The mere fact that a company of such repute should take account of it is assurance enough to bring it to the consideration of marine engineers.

One theory advanced is that the tremendous pressure of the water on the blades would act in the same manner as a knife blade drawn across the face of a sheet of paper, curls it up toward the pressure.

From an extended experience in measuring propeller blades with nearly exact instruments and in measuring blades over different points of their surfaces, the author has found that even in the most carefully made blades there are small hills and hollows. These uneven surfaces traveling through the water at such a high speed, would tend to form little eddies and bubbles which would in all probability leave the blade at just that point where the chipping is shown. As they are swept together there is reason to believe that a partial vacuum might be formed and the blade bending to the form of least resistance takes a permanent set.

When the liner Paris was recently overhauled, her propeller blades were polished with a buffing wheel, which, considering the enormous amount of surface friction, when the propellers are moving, should materially increase their efficiency. At the present writing she has just crossed the ocean, and it is to be regretted that very stormy weather prevented any comparison between this and some of her former runs.

It is a great pity that a more general use of exact instruments are not used on propeller blades at every docking of well known vessels, as then their performance could be watched intelligently by the engineering world; it would be of great benefit and would probably bring to light many interesting points not at present thought of. Notwithstanding the greater expense, propellers could be ground to an exact pitch at every point and then something definite could be known of their performance.

Until some scientifically minded engineer with large means at his disposal will make an extended set of experiments with ample provision for recording exact data and with every point watched, the designing of propellers will always be to a large extent in the nature of guess work. Reason and experience have done much, but the nearly exact science must wait until such experiments are made.

NEW WHITE STAR FREIGHT AND PASSENGER TRANSATLANTIC LINER CYMRIC.

The ownership of the largest freight steamship afloat has again passed to the British flag in the new leviathan "Cymric." This latest addition to the great cargo fleet of the White Star line, trading between Liverpool and New York, reached this port last month on her maiden voyage. In general design she is of the Harland and Wolff type and when loaded is really a handsome vessel, getting a gracefulness of appearance from the rake of the big funnel and four pole masts which is notably absent in many recent big freighters. Her dimensions are: Length over all, 600 ft.; beam, 64 ft.; and depth, 42 ft. When loaded to 29 ft. mean she carries 12,500 tons, cargo in her holds and coal in the bunkers. Her measurement capacity is 19,000 tons of 40 cubic feet.

Strictly speaking the "Cymric" is not a freighter, but rather one of the growing type known as intermediate. This, of course, implies the addition of limited passenger accommodation to cargo capacity, and also medium speed. The "Cymric" carries only one class—saloon—and the accommodation for 120 passengers. This feature of the vessel is perhaps the most interesting, for otherwise she does not differ materially from many ships the builders have turned out. The spaciousness and convenience of arrangement of the passengers' quarters are exceptional. Accustomed to the accommodations on big liners the experienced sightseer could hardly believe himself on board ship. Each cabin is really a good sized room with two berths, upper and lower, a lounge, separate wash stands and a large clothes press. The passages are exceptionally wide and the toilet arrangements splendidly sanitary. In the matter of decoration, as in fact in all such details throughout the ship, there is a substantial plainness in which comfort and solidity are sought rather than showiness.

The saloon is amidship on the upper deck, and is capable of seating about 100 passengers. The dome of the saloon is fitted with a colored glass skylight, also emblematic side panels in plaster of pleasing effect. Pantries, galleys and officers' quarters are on this deck. Immediately above is the promenade deck, where are the passengers' staterooms. Proceeding up the main staircase, lighted by a colored glass skylight, and immediately forward of this, is the library, a pleasant apartment quietly decorated in carved oak panelling. The upholstery is of blue moquette. The furniture consists of writing tables and bookcase, and enticing arm chairs.

Aft of this comes the smoking room, lighted at the sides with large open square windows, and overhead with a colored glass dome. The walls are decorated with French embossed leather, and the furniture is of mahogany, Chippendale pattern. The floor of this room and the main passages and entrances have all been laid with rubber tiles which, besides their noiselessness, contribute greatly to reduce the risk of passengers falling in bad weather. The captain and officers are berthed in a separate house forward of the passengers' quarters, and on the top of this house is the captain's bridge.

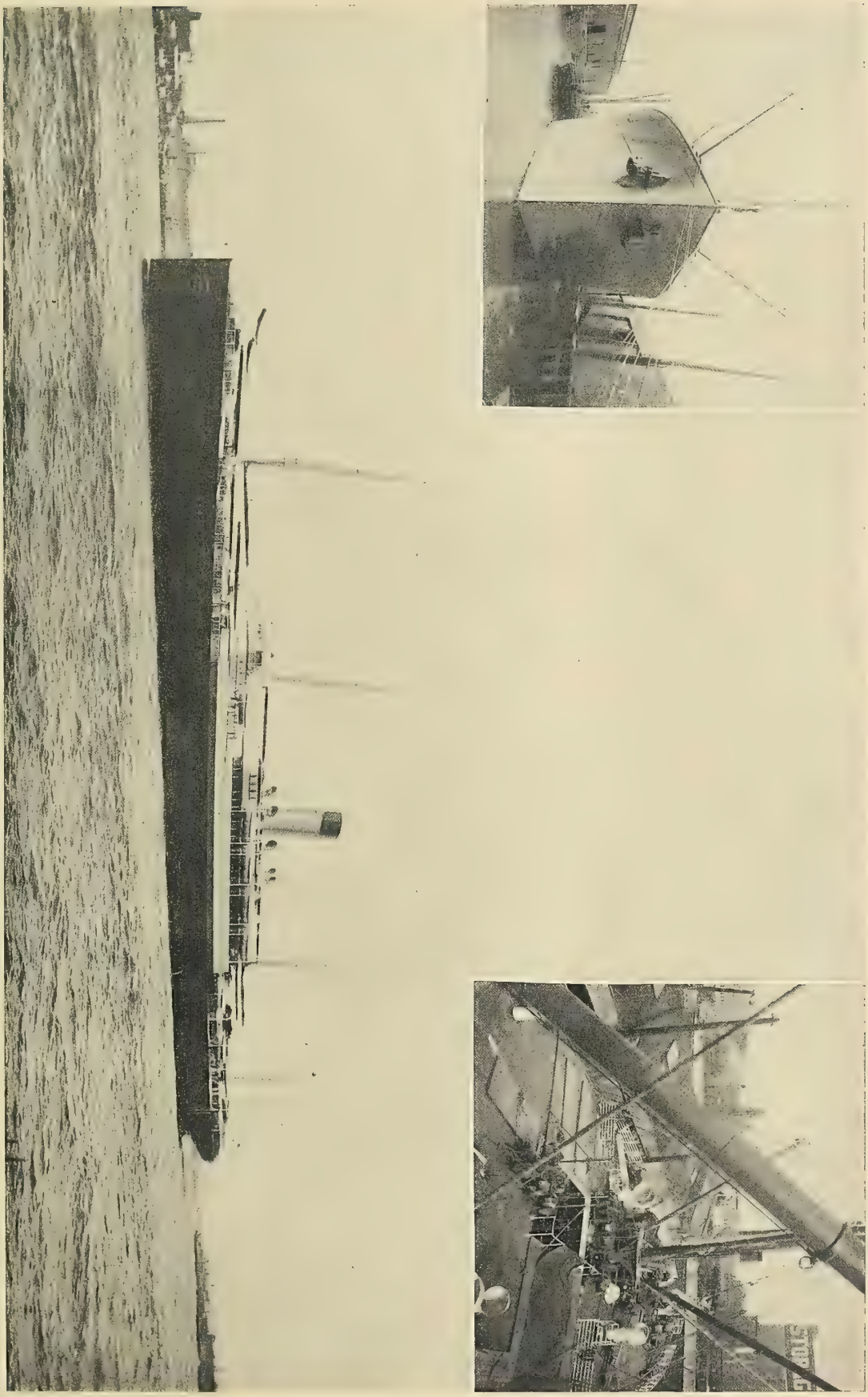
The "Cymric" is fitted with twin screws driven by quadruple expansion engines of about 7,000 I. H. P. of the type usually adopted by the builders, with independent cylinders. Steam is generated in Scotch boilers at 210 pounds per sq. in., natural draught being relied upon. The boiler installation is extensive, as owing to the number and size of the winches, and other auxiliary machinery, single-ended main boilers are used in port to furnish steam. The engine room extends the width of the ship, and is almost big enough to give a cycle path around the engines. In this there are fitted batteries of pumps, feed heaters, evaporators, besides a large refrigerating plant and on one of the upper gratings the electric lighting sets. A feature noticed in the engine room was the order "Dead Slow" on the ahead side of the telegraphs, and "Close Water-Tight Doors" on the astern side. The only serious defect in the machinery equipment appears to be the lack of an elevator, for it is quite an undertaking to run up and down the ladders from the berth deck to the starting platform.

Besides the cargo and passenger accommodation the "Cymric" has room for 850 head of cattle and 250 horses. She flies the Royal Naval Reserve flag, and is constructed so that she could be readily converted into a troop ship and carry an enormous number of men. She is said by her owners to be capable of a 16 knot speed on 100 tons and 13 knots on 80 tons coal consumption. She is fitted with bilge keels, and is described as being "as steady as a church" at sea.

DETAILS OF CONSTRUCTION OF THE TWIN-SCREW STEAM YACHT NIAGARA.

In our last issue we briefly noted the launching of the twin-screw steam yacht Niagara at the yard of Harlan & Hollingsworth, Wilmington, Del. Through the courtesy of her owner, Howard Gould, of New York, we are now able to give interesting information and exact data about this full powered vessel. An excellent idea of the Niagara as she will appear when ready for sea can be had by an inspection of the accompanying sail plan. Though fitted with twin screws she is designed to carry a considerable spread of sail, barque rig, so that in long cruises the method of propulsion can be alternated between steam and sail.

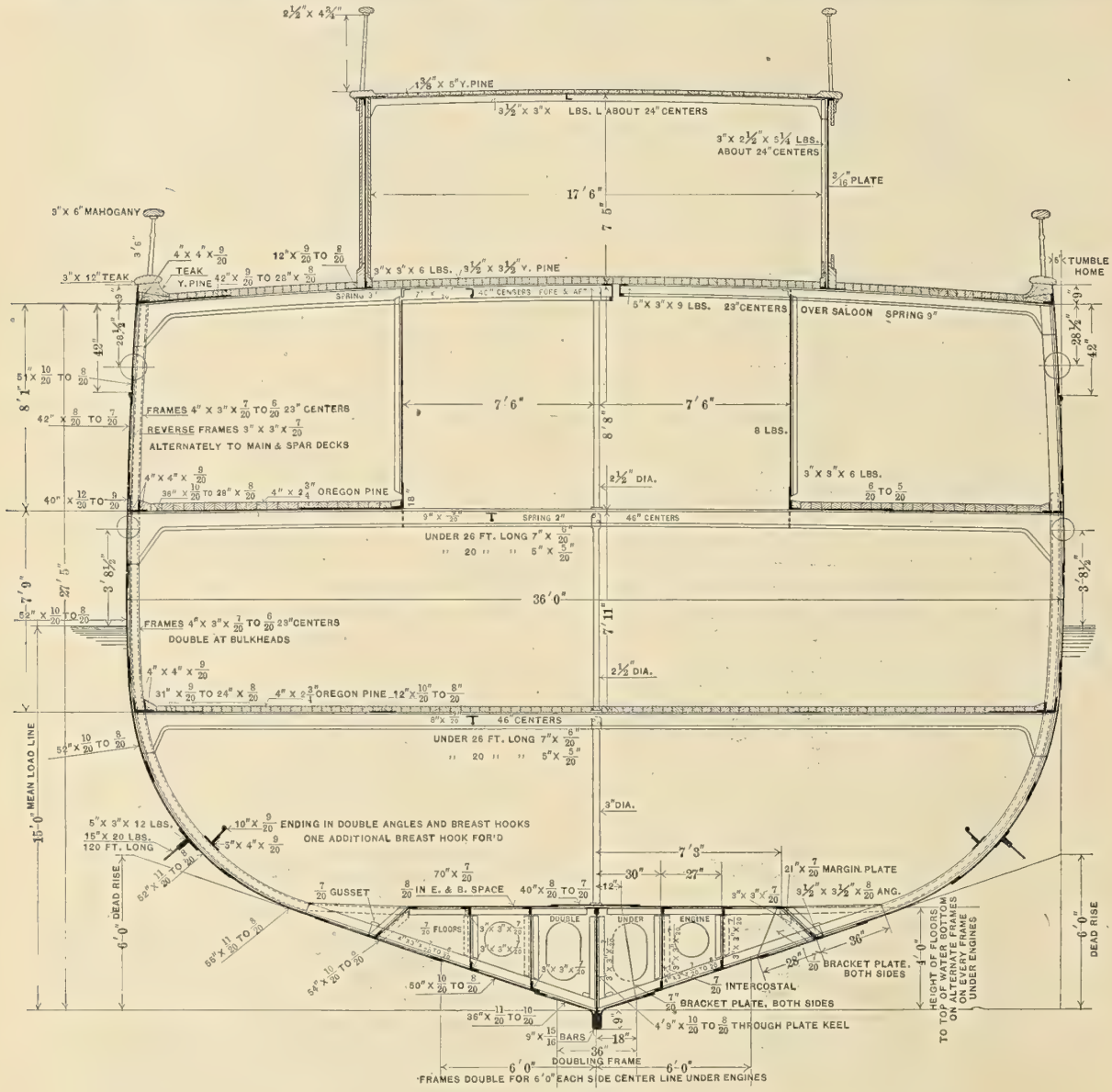
The yacht has been built according to the highest classification of the English Lloyds and American, United States, Standard being for 20 years rated under special survey. She is built of steel with main deck of steel throughout and spar deck partly of steel. Her dimensions are:



VIEWS OF THE WHITE STAR FREIGHT AND PASSENGER TWIN-SCREW STEAMSHIP CYMRIC—THE LARGEST CARGO CARRIER AFLOAT.

Length over all, about 272 ft.; length between perpendiculars (Lloyds measurements), 247 ft. 6 in.; breadth moulded, 36 ft.; depth to spar deck at sides, 27 ft. 5 in.; depth to spar deck at center, 28 ft. 2 in.; depth moulded to main deck at center, 19 ft. 6 in.; depth moulded to main deck at side, 19 ft. 4 in.

She has six water tight steel bulkheads and fore and aft bulkheads in the bunkers. These largely for skylight sills, for covering planksheers, and for waterways. Mahogany will be used for the rails and for the paneling of the deck house. The navigating bridge, which will be 7 ft. wide, will be framed in teak fitted with highly polished telegraphs and binnacle stand, and the other usual appliances. Special attention will, indeed, be given to all the deck fittings, the various ladders being handsomely mounted and



MIDSHIP SECTION OF TWIN-SCREW STEEL STEAM YACHT NIAGARA.

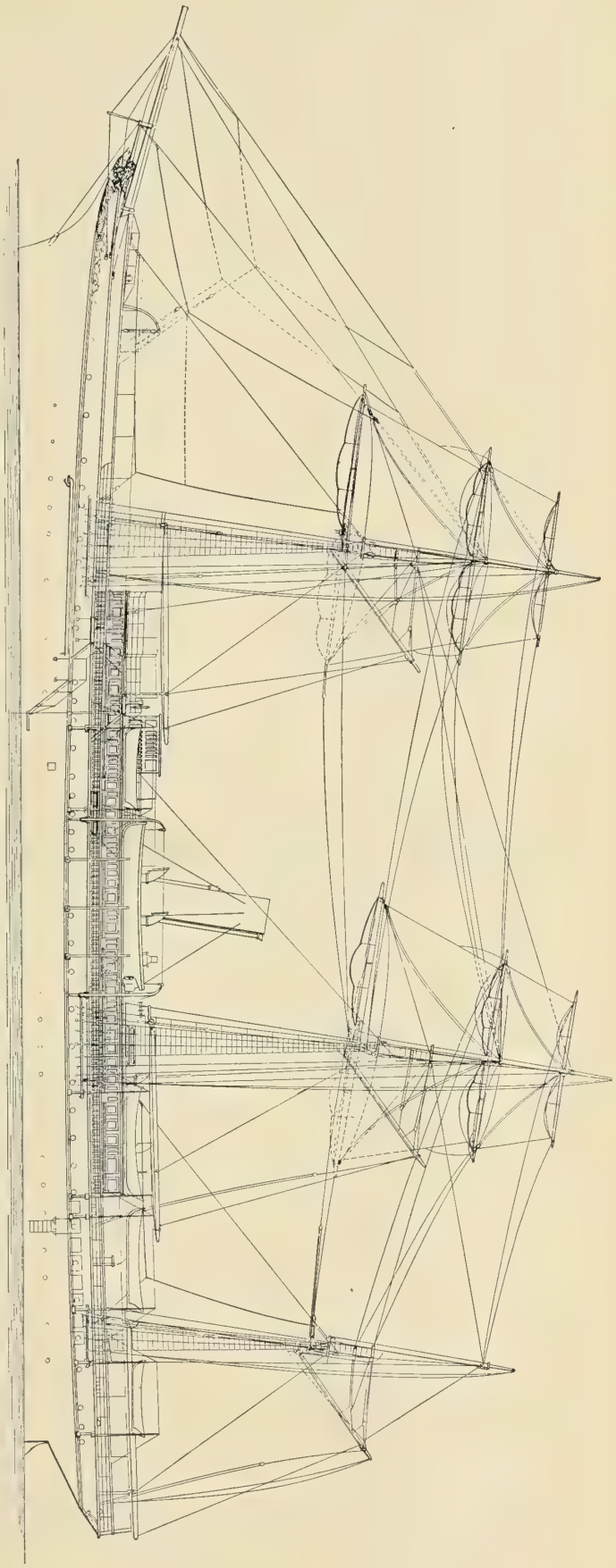
water tight 'thwartship bulkheads are of extra strength and thickness. The hull is divided into several independent compartments for additional safety, and a water bottom for the entire length of the ship is an additional protection. Bilge keels have been fitted for about 140 ft. in length and 15 in. deep, so it is expected she will be very steady in a seaway. The deck house will be of teak and this timber will be used fitted. The figure head and stern carving will be very artistically executed. The decks will be laid with fine white pine, except the lower, which will be of Oregon pine. There will be side lights of improved pattern in brass frames with cast iron shutters in the hull, and screw deck lights and dead lights for light and ventilation where necessary. Very great care has been taken with the design and obstruction of the rigging, blocks,

spars and lines. There will be a very complete installation of steam deck machinery, including steering gear, capstan and windlass forward, and independent steam capstan aft, together with a special steam winch on the forecastle for quick handling purposes, and a steam engine with two gypsys amidships for the sole purpose of hoisting the steam launches and small boats. An emergency hand screw gear will be placed aft. There will be eleven boats in all, including two steam launches.

The "Niagara" is constructed upon the Lundborg principle of protection to the outboard shafting, which is the same as is used in many large steamers. By this device the usual cast steel hangers which extend from the after part of the hull in two directions and meet in the boss supporting the outboard shafting close to the propeller wheel is dispensed with, and in its place the hull is carried out to enclose the shaft within itself and form an integral part of the structure.

The engineering features of this vessel are extensive. Two triple-expansion engines of the usual inverted type are fitted, each with cylinders 18 in., 28 in. and 45 in. by 30 in. stroke, taking steam from three Scotch boilers. These are 13 ft. 6 in. by 11 ft. 6 in. in the clear, each fitted with three 46 in. furnaces, and proportioned for a working pressure of 160 pounds per sq. in. There is also a donkey boiler of the Scotch type, 6 ft. 10 in. dia., and 9 ft. 2 in. long with one 40 in. furnace built to withstand 160 pounds steam pressure. An auxiliary condenser of 306 sq. ft. cooling surface is located in the engine room and provided with a combined air and circulating pump. The water cylinder of this pump is also connected with the water bottom of the vessel for discharging the same quickly in case of necessity for regulating the trim of the ship. This auxiliary condenser is intended to take care of the exhaust steam from the small machinery, such as electric light engines and pumps when the vessel is at anchor and the main engines are stopped. The usual pump equipment for a vessel of this size is fitted, and there is an ash ejector in the fire room.

The electric light plant consists of two direct connected dynamos and engines installed in duplicate, each set having a capacity of 400 16 c. p. lamps. These four pole generators are



SAIL PLAN OF THE TWIN-SCREW STEEL YACHT NIAGARA BUILT BY HARLAN AND HOLLINGSWORTH FOR HOWARD GOULD OF NEW YORK.

driven by 6 in. by 5 in. double enclosed Sturtevant engine running at a speed of 550 revolutions per minute under a boiler pressure of 100 lbs. The wiring of the ship has been done by the electrical staff of the builders, and the whole installation will be finished complete at their yard with their own expert workmen. The various outlets are grouped on six circuits and the insulation and wiring most approved, with all provisions possible for safety and artistic effect. The plant is provided with the usual instruments and spares for operation at sea. There will also be one polished brass, Rushmore pilot house projector, 18 in. dia. taking 45 amperes.

A storage battery of 40 lights capacity will also be installed.

The refrigerating plant is to consist of a Remington machine with a capacity for 400 lbs. of ice per day, and to cool 1,500 cu. ft. of space to a temperature of 34° F. The machine will have two 4 in. by 9 in. vertical single acting ammonia cylinders on one housing, operated by 7 in. by 7 in. vertical engine direct connected on the same base; also one ammonia condenser of the submerged type consisting of a salt water tank with ammonia liquifying coils of extra heavy pipe. There will be one steel brine tank, 5 ft. 4 in. long by 2 ft. 8 in. wide, and 36 in. deep, with removable covers, provided with the necessary ammonia expansion coils, and arranged to contain 15 galvd. ice cans with covers, to hold 50 lbs. cakes of ice, also one 3 in. by 2 in. by 3 in. duplex steam pump, brass mounted, for brine circulation, with brine gauge, lubricator and brass cased thermometer. A system of galvanized piping will be erected in the cold storage room and refrigerators for the circulation of the brine and governed by suitable valves and connections. There will be two ammonia gauges mounted on ornamental board, and one ammonia receiver and connecting pipes, valves and fittings for the system.

In connection with the machinery department there will be an evaporator and distiller plant of 15 tons capacity, fitted up complete.

The ship will be steam heated throughout with radiators, coils and pipes, the whole being trapped and discharged into the hot well or filter tank in the engine room.

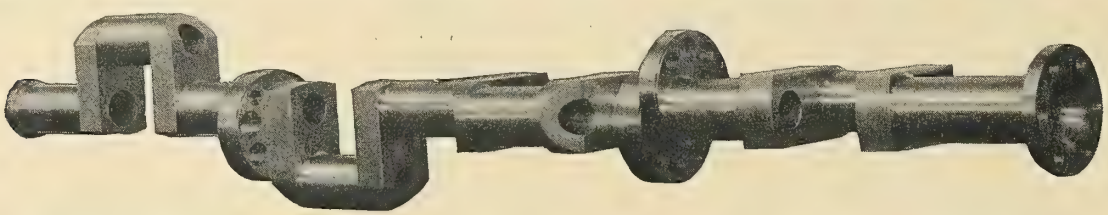
The plumbing system is very complete, consisting of salt and fresh water supply throughout the ship, lifted by steam pumps and the salt water waste being carried overboard and the supply tanks located on top of the deck house. Drains from all basins and tubs in the owner's and guests' quarters are led into a 500 gallon drainage tank in the hold and drains from all water closets in the owner's and and guests' quarters are led into sewage tanks located in the hold and thence pumped overboard by steam or water syphon blow. Ventilation is carefully looked after in every part of the system.

Fresh water tanks of 15,000 gallons capacity are fitted independent of the fresh water to be carried in the peak tanks. There is bunker capacity for 425 tons. At maximum speed the estimated horse power is 2,000, and with bunkers full and no water in the water bottom, but with all other weights on board a speed of 14 knots is looked for on a six hours' trial, running under natural draught.

We have not here given any description of the interior arrangements or furnishings, as many of the details have not yet been finally decided upon. When the yacht is ready for sea, however, we expect to give additional description of these matters. The hull construction can be readily seen by reference to the accompanying cross section.

Nickel Steel Crank Shaft for Destroyer.

As an interesting example of modern practice in marine forgings we here present a reproduction of a photograph of a nickel steel four-throw crank shaft for the torpedo boat destroyer Farragut, now building at the Union Iron Works in San Francisco. This crank which was forged and machined by the Bethlehem Iron Co. at South Bethlehem, Pa., is 12 ft. 8 1-2 in. long. The journals and pins are 6 3-4 in. dia. and the diameter of the through hole is 4 in. As will be observed the forging is in one piece, with the eccentric sheaves in place. Every ounce of metal which could be spared is cut away, the lightening process even extending to the drilling of the eccentric sheaves. The Farragut is designed for a speed of 30 knots. Her dimensions are: Length, 210 ft.; beam, 20 ft. 4 in.; draught, 6 ft. Her displacement will be about 270 tons and her engines are expected to indicate 5,600 horse power. These will have cylinders 20 in., 29 in. and two 30 in. dia. by 18 in. stroke. They will have link motion and piston valves, and are designed to make 400 revolutions. The boilers will be of the Thornycroft water-tube "Desperate" type, to work at 240 lbs. pressure.



SOLID FORGED FOUR-THROW NICKEL STEEL CRANK SHAFT FOR THE "FARRAGUT."

REVIEW OF ADMIRALTY LAW SHOWING ITS ORIGIN AND MODERN APPLICATION.*

BY ISAAC FRANKLIN RUSSELL, D.C.L., LL.D.

Admiralty jurisprudence is the most ancient and cosmopolitan body of law with which we are familiar. Some of its rules now generally enforced were formulated in the Rhodian law several centuries before the Christian era. Rhodes was then the center of commerce in the Mediterranean. Fragments of this ancient code are preserved in the Corpus Juris; for example, the rule of general average which still survives in the maritime law of to-day. Among the maritime codes of the Middle Ages we find the laws of Oleron, which, by an English fable, are ascribed to Richard Coeur de Lion, who stopped at the island from which the code takes its name on a visit to his mother-in-law, on his return from the Crusades. But law was not in the line of the lion-hearted king, and the story is apocryphal, being invented in order to credit England with some contribution to the maritime law. The Consolato del Mare and the marine ordinance of Louis XIV., the basis of the French Code de Commerce, deserve mention among the sources of the admiralty law.

The word ship is very general, and comprehends watercraft of every kind, merchantmen, gunboats and pleasure yachts; size and rigging are also immaterial, for every vessel that floats is in law a ship. Obviously, a vessel constructed to ply on the highway of nations cannot be real estate. Gunboats, however, by a fiction of law, are regarded as floating barracks.

A ship is a chattel, and is to be bought and sold under the law of chattels. In strictness of law a ship can be sold without writing; but practically this is impossible, because statutes require documentary proof of ownership before papers are issued from the office of the collector of the home port. And papers, a register for a ship in the foreign trade, and a license for a coaster, are in every case necessary for seaworthiness: They are as important as the helm or anchor. It is characteristic of admiralty that it treats of things as persons. A ship, for instance, is regarded as a responsible moral agent.

Repairs are charged to a ship in her own name, and payment is enforced against the ship herself by a proceeding against her, in rem. in which under a decree in admiralty she is sold and the proceeds applied according to law. So, too, a ship is regarded as having nationality as well as personality, and, further, like an ordinary citizen, as having a distinct domicile, or home port. The maritime law gives a lien to the material-man who furnishes repairs and supplies to a ship. But in the United States this is limited to foreign ships or ships of another State.

One of the most discouraging features of practice at common law is the familiar experience of the successful litigant in finding himself unable to satisfy his judgment; during the long course of the suit the defendant has become insolvent. Now, the admiralty begins where the common law leaves off, viz., by seizing the ship and holding her as security for such judgment as may be rendered. Her owners may secure her release by giving a bond. So, in actions against the owners, if defendants cannot be served personally by a writ of attachment the ship is attached. The marshal—who knows his business—is unable to serve the defendant personally, but always suceeds in seizing the ship.

Ships are seldom owned by a single individual outright; they generally belong to several persons called part owners. Of these the managing owner is called the ship's husband. The commander, or captain, is known in law as the master. He is the highest authority in the ship. He is not only agent of the owners by contract, but by necessity he is agent for all whose time, labor and fortunes are involved in a common venture. The master can sell the ship in case of necessity where he acts with ordinary prudence. As agent for all interested, he may even sell the cargo. The owners of a ship may sail her themselves, or they may lease her to others by a contract called a charter-party. The ship is bound to the cargo, and reciprocally, the cargo is bound to the ship. The ship must be seaworthy and make the voyage and deliver the goods in accordance with the terms of the contract; and as a carrier the ship owner has a lien on the cargo to enforce payment of freight. When the goods have been laden on the ship the lien attaches, and the ship has a right to earn freight, which right cannot be ignored by an attaching creditor.

A bill of lading is a written receipt for the goods shipped, and is signed by the master; it is often executed in triplicate. If an indorsed bill of lading be delivered to the consignee it entitles him to delivery of the goods shipped. Such a bill is quasi-negotiable; it may be hypothecated as security for money advanced, or it may serve as a muniment of title and facilitate symbolically the delivery of goods sold to arrive. The owner of a general ship, offering to take goods for all who may apply, is a common carrier, and as such is bound to answer for all loss except such as results from the act of God or the public enemy. By stipulation in the bill of lading, loss from the perils of the sea is also excepted. This expression means the extraordinary violence of wind and wave, wreck, stranding and capture by pirates or by the cruisers of a belligerent enemy. By act of Congress the ship owner is not bound to answer for loss arising from fire at sea not caused by negligence.

Collision is now the chief maritime peril. The ship in fault sustains its own loss and is bound to compensate the other party. The common-law rule of contributary negligence has no application in cases of collision. To encourage owners to assume the risks of maritime commerce

*From a lecture delivered before the Brooklyn Institute, New York.

the law limits the liability of the owners of the offending vessel to the amount of the value of the ship herself. So if the ship causing the loss or injury be herself sunk there is no responsibility.

Salvage is compensation earned in saving a ship or cargo exposed to maritime peril. There must be a marine peril, a voluntary service on the part of the sailors, and successful achievement. The master and crew of the ship in peril cannot be salvors, for their best service is always due as a consideration for their wages. But a passenger may be a salvor. The sum awarded is not in the shape of wages for services rendered at their ordinary rate and value; the money partakes rather of the character of a reward estimated in view of the nature of the peril to which the property saved was exposed.

Seamen are regarded as the wards of the admiralty and are protected by law against the overreaching schemes of landsmen. The exigencies of maritime service are such that disobedience may be punished with great severity; and mutiny, if need be, with death. The usual punishments are irons, confinement and hard labor; flogging has been abolished by statute. Desertion may be justified if the ship be unseaworthy or the provisions bad and unwholesome, or in case of cruel and inhuman treatment. Absence unexplained and without leave for forty-eight hours has been defined by some authorities as amounting to desertion.

Maritime and admiralty jurisdiction is vested by the Constitution in the Federal courts. It has been developed and expanded by those tribunals without the aid of statutory enactments. Procedure follows the system of the civil-law courts as distinguished from the common-law courts. The first pleading is called the libel, and the applicant for judicial relief is called the libellant. Legal practitioners are styled proctors, and much other technical language in admiralty is borrowed from the Roman law. The long and bitter controversy in England between the common-law courts and the admiralty resulted from a jealous regard for trial by jury, which the admiralty did not employ. Although federal legislation has provided for the use of a jury in admiralty cases it is seldom, if ever invoked. In strict admiralty practice the testimony of witnesses is taken before the final hearing; it is reduced to writing and the witness dismissed before the trial comes off before the judge.

In the death of Nelson W. Perry technical journalism loses one of its most talented writers and an exceptionally fine man. Mr. Perry was a student in all fields of science and had the rare faculty of telling of complicated or abstruse things in such plain, simple language that anybody could understand him. He wrote a great deal, but was such a close observer that his articles were never diluted. Personally he was a delightful companion, and had many friends.

ICE CRUSHING AND FERRY STEAMERS AT THE STRAITS OF MACKINAC.

BY W. D. HULBERT.

During the last sixteen years the Straits of Mackinac have been the scene of some remarkable experiments in winter navigation through fields of heavy ice. The Detroit Dry Dock Company has built three steamers especially for this work, and, although the first was a partial failure as an ice-crusher, the other two have been completely successful. The Algomah, launched in 1881, is a comparatively small vessel of 486 tons. She measures 128 ft. in length of keel, 33 ft. beam, and 14 ft. molded depth, and is driven by compound engines measuring 21 in. and 37 in. by 36 in. Her depth is greatest at the stern, and the keel rises forward till it rounds up out of the water somewhat like the nose of a whaleback. She was intended for use as a ram, and the hull was, therefore, made very heavy and strong, especially in the forward portion. The theory on which she was designed was that the peculiar shape of her bow would force the ice down under her, and that in striking a heavy floe she would rise upon it and crush it beneath her weight. She worked fairly well in smooth field ice, but experienced great difficulty in getting through the hummocks that were frequently met with, and was sometimes quite helpless until a passage was opened for her with dynamite. It was found, however, that she could sometimes make her way stern foremost through places where her ram was practically useless. To do this her stern was brought to bear against the obstruction, the vessel was made fast to the ice with anchors, and the engine was started ahead. The powerful current set in motion by the propeller heaved up the ice for a short distance around her stern, and broke it into fragments. The boat was then backed as far as possible into the broken mass, a new hold was taken with the anchors, and the operation was repeated. The success of these experiments led to the building of a larger boat, the St. Ignace, with a propeller at each end, the two wheels working in unison or against each other as is required. The one in the bow throws a current of water forward and breaks up the ice, while the stern wheel, which is larger and driven by more powerful engines, drives the boat ahead. The channel made is only wide enough to admit of the passage of the vessel, and frequently a man can jump from her side to ice sufficiently solid to sustain him. The same path is followed day after day, but it is often filled up with slush or broken ice which freezes in solidly and has to be broken open again, or by the movements of the floes in high winds. When not needed in opening a channel, the forward wheel can be used to assist the stern wheel in propelling the vessel.

The St. Ignace has a length of 232 ft., beam 50 ft. 10 in., and depth 24 ft. Her tonnage is

INSTANTANEOUS PHOTOGRAPHS OF ICE CRUSHING AND FERRY STEAMERS AT WORK IN THE STRAITS OF MACKINAC.

1,199.75. The propelling machinery consists of two compound engines, the forward one having cylinders 26 and 48 in. dia. by 40 in. stroke, while the after engine measures 28 in. and 53 in. by 48 in. Steam is supplied by three double-ended boilers, each 11 ft. 6 in. dia. by 18 ft. in length. The cars are loaded at the bow and are carried on two tracks laid upon the deck, one on each side, next the gunwale. The two funnels are ranged fore and aft in order that they may occupy less space between the tracks. The St. Ignace was the first boat on the Great Lakes to have her funnels arranged in this manner.

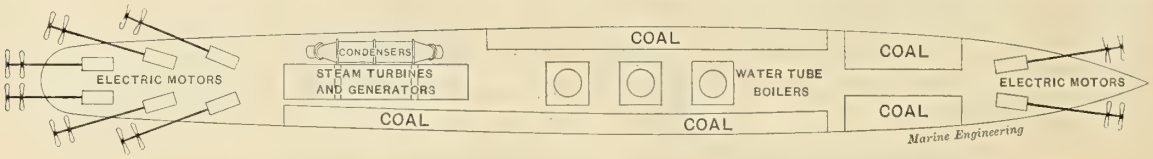
The Straits are roughest in westerly winds, and as the course of the ferryboats is about northeast and southwest they are frequently in the trough of a very heavy sea. The St. Ignace, with her proportionately great breadth of beam, is a very steady vessel, but it was thought advisable to increase her stability still further in order to avoid all danger of the cars being thrown from the tracks, and she was, therefore, fitted with two large anti-rolling tanks, which, it is claimed, very materially reduce the lateral motion. On top of her pilot house is a powerful electric search light, which is often of great assistance in picking a way through the ice-packs on a dark night, and which can also be used in lighting up the forward deck when loading or unloading cars. She is very heavily and substantially built, and in general appearance somewhat resembles a modern man-of-war. She was completed in the late winter or early spring, and was sent north while a large part of Lake Huron was still covered with ice about two feet in thickness. The voyage was

made without difficulty, and she is said to have maintained a speed of about five miles an hour throughout the greater part of it.

For several years the St. Ignace continued to handle the entire winter traffic of the Straits, and she seldom had any difficulty in navigating through the ice, but she was rather small for the amount of freight to be carried. In 1893 a larger vessel, the Ste. Marie, was constructed. Frank E. Kirby was her designer, and, like the other two boats, she was built by the Detroit Dry Dock Company. She is 269 ft. 6 in. in length of keel, 302 ft. on deck, 51 ft. 6 in. beam, and 24 ft. in molded depth. Her freeboard when carrying an ordinary load of eighteen freight cars is about 9 ft., and is none too great, as may be seen by the accompanying photograph. The hull is of the strongest possible construction, and her builders claim that it is the heaviest wooden hull on the Great Lakes. It is of oak for the most part, some long-leafed Georgia pine being used for deck beams and track stringers. The frames are 12 in. thick by 24 in. deep on the keel. There are 15 keelsons, none less than 14 in. square, and the vessel is planked with 6 in. of oak and sheathed with steel, up to 1-4 in. thick, to keep the ice from chafing her sides. Her coefficient of displacement is less than five-tenths, and her deep draught and fine form under water are important factors in her success. The upper deck of the hull proper is occupied by three tracks for car accommodation, one down the middle and one on each side, the cabins being carried overhead on the hurricane deck. The sides are sheathed up so that the cars are under cover in transit, and the usual appliances in the way of jacks and chains are used to steady them on the tracks. Owing to the length of the trip and the number of passengers carried, the cabin accommodations, dining saloon, toilet rooms, etc., are superior to those usually found on car ferries. Steam is furnished by four double-ended boilers, each 11 ft. 6 in. dia. by 17 ft. 6 in. long, working at a pressure of 120 lbs. to the sq. in. The funnels are four in number and are arranged in two pairs, rising on either side of the middle track. She has two vertical inverted compound engines of about 2,500 indicated horse power for ordinary working. The one which drives the bow wheel has cylinders 28 in. and 52 in. dia. by 40 in. stroke, while the after engine measures 32 in. and 58 in. by 48 in. The air pumps are of the Worthington independent duplex type, the size of the forward one being 12 in. by 15 in. by 15 in., and the after one 14. in. by 19 in. by 15 in. Feed pumps are also independent of the main engines, leaving only the bilge and circulating pumps to be worked direct. The auxiliary machinery comprises also four steam gypseys for handling lines, an engine for hoisting the gate at the bow under which cars must run in loading and unloading, and an engine and dynamo which supply current to 300 electric lamps and for the search light on the pilot house. Among the special fittings are four of the Dry Dock Company's hydraulic ash ejectors for getting the ashes overbard.

Like the St. Ignace, the Ste. Marie carries anti-rolling tanks to steady her in the high waves and rough cross seas of the Straits. As an ice-crusher she seems to be perfectly adapted to the work required, and her daylight trips are made as regularly in winter as in summer. A howling gale, loosening the floes and setting them in motion, sometimes causes her to cancel her night trip and remain at the wharf till morning, but even this is of very rare occurrence, and the delay in such cases is more a matter of prudence than of actual necessity. For the last four years she has done practically all of the car ferrying between the upper and lower peninsulas, the St. Ignace being held in reserve for use in case of accident to the larger boat or during the semi-annual overhauling which is given her every spring and fall to keep her in condition for her battles with the ice-pack.

The Mackinac ice-crushers have attracted a great deal of attention from naval architects all over the world, and the Russian government sent experts to examine them before deciding upon similar vessels for use in transferring cars across Lake Baikal, on the line of the Trans-Siberian Railway.



ROUGH SKETCH OF PROPOSED ELECTRICALLY DRIVEN TORPEDO BOAT.

Proposed Electrically Driven Torpedo Boat.

We here print a rough sketch of a type of torpedo boat proposed by Richard B. Painton, which is the subject of a bill to be presented to Congress for an appropriation for the construction of such a boat for the Navy. The inventor is very hopeful of results, and his claims are correspondingly proportioned. By the use of his system, he says, it will be possible to attain double the speed reached by steam and at about one-half the cost. Ocean "greyhounds" equipped with the Painton motors are to "easily cover 40 knots an hour." As the sketch shows, the inventor proposes to fit his boat with water-tube boilers supplying steam to steam turbines direct-connected to generators, which will furnish current for the several electric motors attached to the propeller shafts. Multiple propellers are used so as to get

the required blade area on small diameter. In his prospectus the inventor declares his system of motors will have "enlarged power" over steam. How the enlargement of power is provided, however, is not stated. It is manifest that he would secure "enlarged" weight, and consequently displacement, for in addition to the boilers and turbines, such as are used in the "Turbinia," for example, he adds the weights of generators and motors besides the various controlling and measuring devices for the electrical current. In the best land practice, where weight is not a matter of first consideration, the drop in efficiency between the engine and electric motor is about 13 per cent., and in all rational discussion this would mean contraction rather than enlargement.

Data on Propeller Investigations.

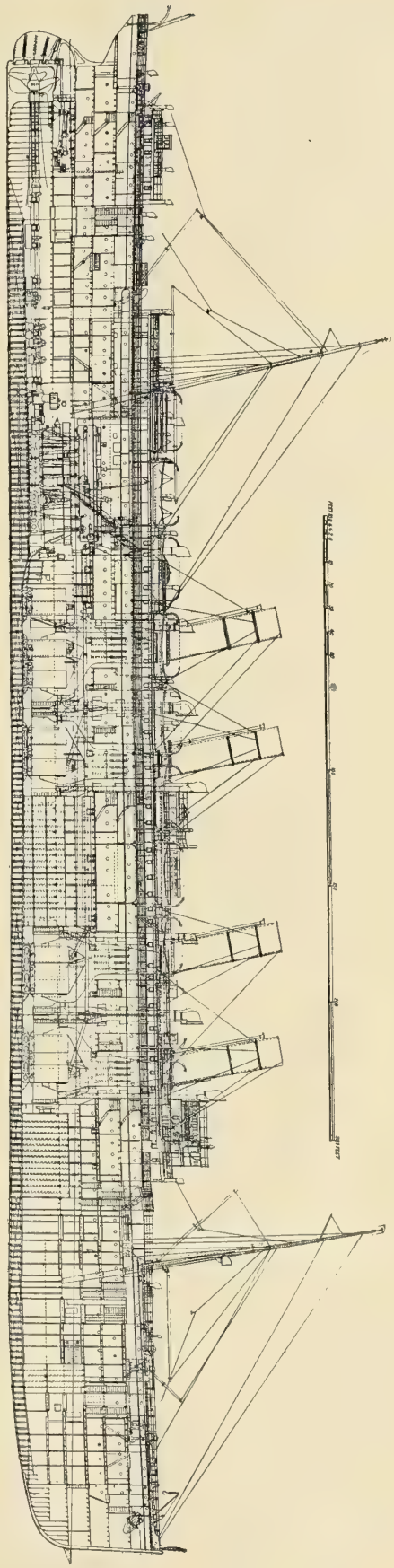
Several correspondents have written asking for additional information regarding the diagrams published in our December, 1897, issue, with the paper on screw propellers by Professor W. F. Durand, which was read at the recent meeting of the Society of Naval Architects and Marine Engineers. In this paper it will be remembered the author treats of the Influence of Surface on the Performance of Screw Propellers. We accordingly print here an index to the diagrams, which will be found useful in their interpretation.

Fig. 12. ..Propellor No. 2. } Upper curves: Work required at constant speed of 100 ft. per mt.
Fig. 13. .. " No. 3. }
Fig. 14. .. " No. 4. }
Fig. 15. .. " No. 6. } Lower curves: Thrust developed at constant speed of 100 ft. per mt.
Fig. 16. .. " No. 8. }
Fig. 17. Thrusts for constant speed of 100 ft. per mt., each curve for constant area as denoted by number.
Fig. 18. Work required for constant speed of 100 ft. per mt., each curve for constant area as denoted by number.
Fig. 19. Thrusts for constant revolutions of 100 per mt., each line for constant area as denoted by number.
Fig. 20. Work required for constant revolutions of 100 per mt., each line for constant area as denoted by number.
Fig. 21. Thrusts for varying surface at 100 revolutions per mt., each curve for constant slip as shown.
Fig. 22. Work required for varying surface at 100 revolutions per mt., each curve for constant slip as shown.
Fig. 23. Efficiency for varying slip, each curve for constant surface as denoted by number.
Fig. 24. Efficiency for varying surface, each curve for constant slip as shown.

The corresponding numbers will be found in the diagrams in the issue above referred to.

North German Lloyd Liners.

In our issue of October, 1897, we published an extensive description of the new North German Lloyd liner Kaiser Wilhelm der Grosse, at the time of her maiden voyage across the Atlantic. We are now able to present a sectional drawing of this the largest steamship afloat, by reproduction from Engineering, London. To repeat the general dimensions of the liner, her length is 648 ft.; beam, 66 ft.; and depth, 43 ft., and her displacement ranging from 17,300 tons on 24 ft. draught to 20,880 tons on 28 ft. draught. She has accommodation for about 600 saloon passengers. The new ship building at Schichau's yard for the company, the "Kaiser Friedrich" will be completed in time for the summer traffic. She is 580 ft. long; 64 ft. beam; and 41 ft. deep. Her engines will develop 17,000 I. H. P.



LONGITUDINAL SECTION OF NORTH GERMAN LLOYD TWIN-SCREW TRANSATLANTIC LINER KAISER WILHELM DER GROSSE.

HIGH PRESSURES AT SEA WITH SOME CONSIDERATION OF TYPES OF BOILERS.*—II.

BY W. R. CUMMINS.

Rankine is of opinion that the transmission of fire heat to water varies as the square of the difference of temperature between the fire and the water, and the experiments carried out by Mr. Blechynden apparently confirm this theory. Mr. Hudson, in a paper reviewing experiments on heat transmission, is of opinion that in all probability the difference of temperature between the two surfaces of a plate, transmitting the same quantity of heat, will be the same whether the transmitting medium be fire heat or steam heat, but that a much higher temperature of medium is required in the case of fire heat to keep up the temperature of the hotter side of the transmitting plate—that is to say, the internal resistance of the plate is the same whatever the transmitting medium may be.

This theory reconciles the apparently contradictory results obtained by experiments with fire heat and steam heat. Fig. 1 shows the results of one set of Mr. Blechynden's experiments on a plate of varying thickness. From it, it will be seen that for thicknesses, varying from 1-2 in. to 1 1-8 in., the transmission for any given difference of temperature varies approximately as the square root of the thickness. Below 1-2 in. thickness, however, the transmission varies apparently as some higher root of the thickness. It should be remembered that these experiments deal chiefly with the effects of radiant heat, and it may be that for convective heat the thinner plates may transmit heat varying as the square root of the thickness.

In Dr. Kirk's experiments, it will be remembered that with thick plates the heat transmission was so small that the plate next the fire became red-hot, the plate next the water being only 212 deg. Fah. From this it would appear that for plates above 1 1-8 in. say, the transmission would vary inversely as the thickness. Hence, in default of more experiments, we may assume in the meantime that the transmission varies as the square of the difference of temperature between the fire and the water, inversely as the thickness of the plate for thick plates, inversely as the square root of the thickness for moderate thicknesses, and inversely as the cube root of the thickness for thin plates. To estimate the effect of the increased temperature of the water due to the increase of pressure from 150 lb. to 250 lb., we may take the mean temperature of the gases in the boiler at 1,400 deg. Fah. The temperature of the water for 150 lb. pressure = 366 deg. Fah., and for 250 lb. = 406 deg. Fah. Then for the same thickness and condition of surface, we have:

$$\frac{(1400 - 406)^2}{(1100 - 366)^2} = .91$$

That is to say, owing to increased temperature of the water we should transmit only 91 per cent. of the heat transmitted under the lower pressure conditions; or, in other words, to transmit the same quantity of heat we would require 9 per cent more heating surface. With the same quantity of heat received we may expect an increase of steam economy of 18 per cent. Hence the higher pressure boiler, to develop the same power, should have 18 per cent less grate surface, but only 9 per cent less heating surface, than the lower pressure boiler, provided the thickness of the heating surface remains the same in both cases.

The importance of keeping down the cost and the space occupied by the higher pressure machinery has been insisted upon in the foregoing, and since the cost of the engines will certainly not be less, and the space occupied if four cranks are adopted may be more, then the whole of the saving must be made in the boiler space. This should be a very important factor in deciding

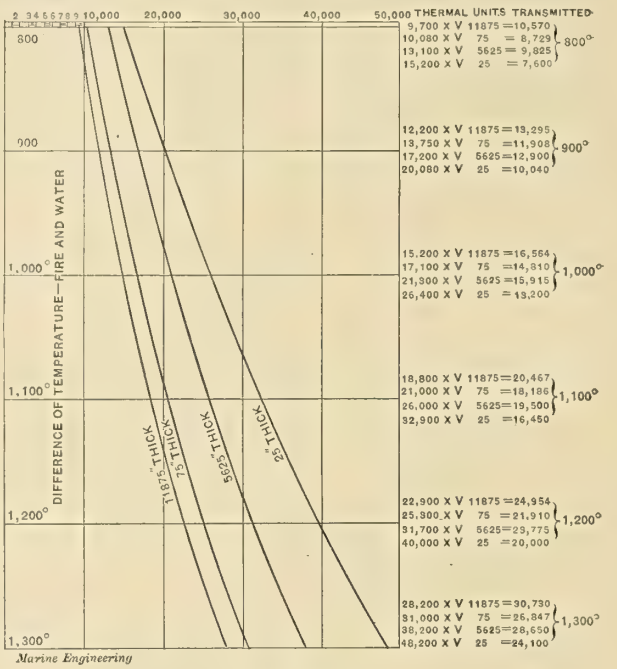


FIG. 1.

upon the best type of boiler for the increased pressure.

A satisfactory boiler for 250 lbs. working pressure suitable for the mercantile marine should have the following qualifications:

First—The design should be such that the pressure may be carried safely with the minimum thickness of the material forming the heating surfaces.

Second—It should have a large and free combustion chamber to allow the gases to combine properly before they lose any of their heat by contact with any of the heating surface.

Third.—After leaving the combustion chamber the gases should be split up into small streams and well distributed over the heating surface.

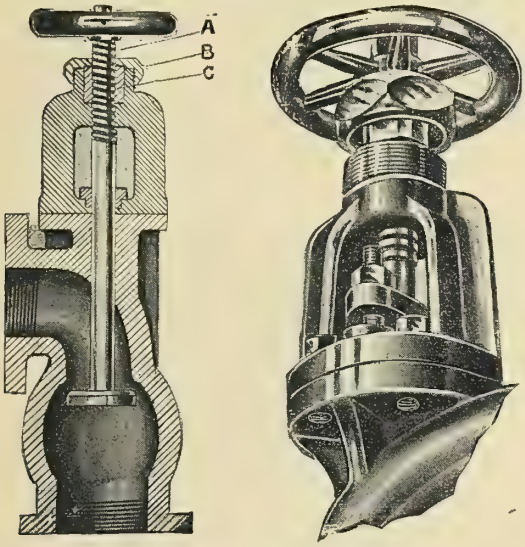
(To be continued.)

* From a paper read at the North-East Coast Institute of Engineers and Shipbuilders in Suhderland, England.

IMPROVED APPARATUS.

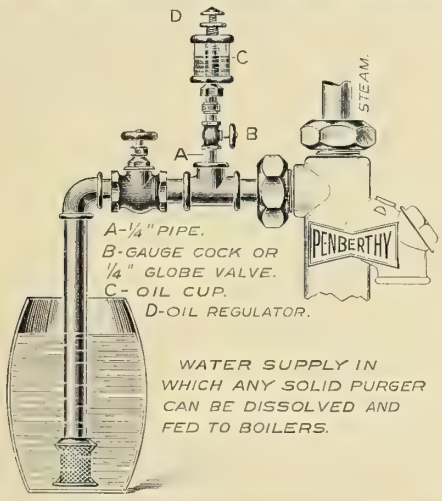
Eclipse Blow-off Valve.

This valve is designed for use on high pressure boilers, and is so made that the stem can be repacked and the seat reground under pressure.



ECLIPSE BLOW-OFF VALVE.

The stem A passes through a nut B and brass screw bushing C held in place by the nut. When the valve needs regrinding the nut B is unscrewed and the wheel turned, causing the bushing to run up the stem, when the bushing is out



ARRANGEMENT FOR FEEDING BOILER "PURGER."

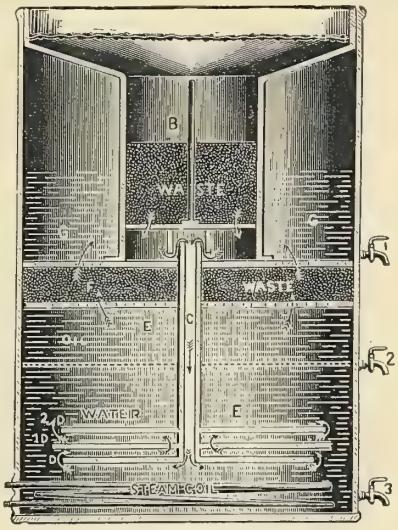
of its pocket the wheel and stem are turned until the face fits the seat tightly; the pressure in the boiler will keep the valve tightly closed during the operation. The John Davis Co., 61 Michigan St., Chicago, Ill., are the manufacturers of this valve.

Boiler Compound Feeding Device.

An arrangement for feeding boiler compounds is here shown as adopted by the Penberthy Injector Co., of Detroit, Mich. The illustration shows it feeding from a barrel through an ejector into the boiler. The "purger" used is dissolved in the water contained in the barrel and then fed through the injector. The oil cup in position over the horizontal pipe is the arrangement adopted when using a liquid "purger," the rate of flow being regulated by the valve B. This arrangement is in use in the works of the company, and its design is not protected by any patents, but is given out by the company by way of helpful suggestion.

Cross Engine Room Oil Filter.

A compact form of oil filter is shown in the sectional engraving herewith. The filtering medium in this is ordinary cotton waste which is placed in the receptacles marked. To operate the filter the steam coil is connected up and clean warm water is poured into the filter until it runs out of cock No. 2. Clean oil is then poured in on top of the water until it shows at cock No. 1. Then the filter is ready for use. The waste oil to be filtered is delivered into the filter at the top, where a wire grating collects any refuse mixed with the

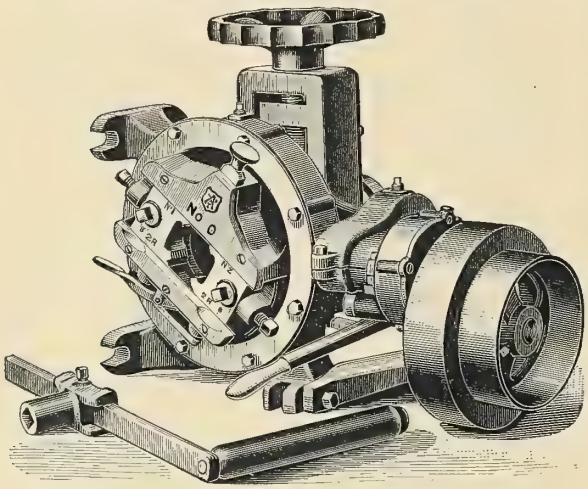


CROSS OIL FILTER.

oil, then the oil passes downward through the central vessel containing waste, where all the coarser impurities in suspension are collected. In this central vessel below the waste there is a chamber provided with baffle plate which causes a regular flow down the central pipe. From this pipe the oil passes into the surrounding heated water over the steam coil and then upward through a somewhat tortuous passage under and over the internal plates shown in the sketch, finally coming out into the body of the filter and up through the cross compartment filled with waste, which extracts any fine impurities which may yet be carried in the oil. It can be drawn off as required through cock No. 1. Cock No. 3 is used in washing out the filter. The filter is made in six convenient sizes, up to a capacity of 120 gallons a day, by the Burt Manufacturing Company, Akron, Ohio.

Pipe Machines With Power Attachment.

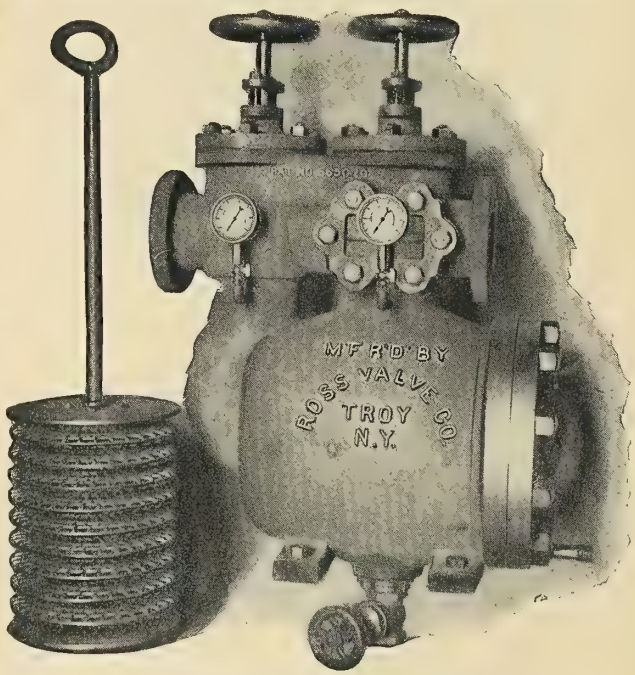
A demand for a "hand" pipe-threading machine fitted with a power attachment has caused the Armstrong Manufacturing Company to design and place on the market the machine here illustrated. This is known as their No. 0 machine with power attachment. The attachment is composed of an extra gear and pinion with a two-cone pulley which is slipped on the pinion of the second speed and has a stay bolted on the base to support it, making it perfectly strong. The engraving shows the machine with attachment for the belt. It is made for threading pipe 1-8 in. to 2 in., or bolts from 1-2 in. up to 1 1-2 in. All working parts are encased so as to keep them free from chips and dust. The gear of the die head does not bear on the head when revolving and therefore does not wear loose by friction. This is considered a very recent improvement on threading machines and makes it impossible for the operator to produce a "drunken" thread. Full particulars can be obtained by addressing the manufacturers, either in Bridgeport, Conn., or 139 Centre street, New York.



ARMSTRONG PIPE THREADING MACHINE.

Feed Water Filter for Marine Boilers.

Accompanying engraving is the exterior view of a filter which has been introduced in marine work by the Ross Valve Co., of Troy, N. Y. It is constructed upon the patents of Railton & Campbell. The engraving shows the cage or filtering apparatus proper, removed and standing at the left of the filter. Upon the several segments of this cage are stretched a fibrous filtering material, and the cage is then placed horizontally in the body of the filter. The valve at the right works between an upper and a lower seat. When it is against the upper seat the feed water, entering at the inlet at the right, passes downward through the filtering material and out through the valve at the left. When the first valve is turned down to the bottom seat the water is by-passed directly to the outlet, and the other valve can be closed to keep it from backing downward through the filter. This valve can presumably be left open to allow the water to back through the filter for purposes of washing out. It will be noticed that the area of filtering surface presented to the action of the water is very large, and that by having a spare filtering chamber the material can be renewed when necessary with but a very brief interruption of the filtering action. The makers claim that the material can be used from one to three months, taken out, washed and used several times before being discarded, and that renewals, even when necessary are very inexpensive. The filtering area supplied varies from 150 to 1,000 times the area of the feed pipe, as may be desirable for the work in hand, and the water passes through the filtering medium with but little friction.

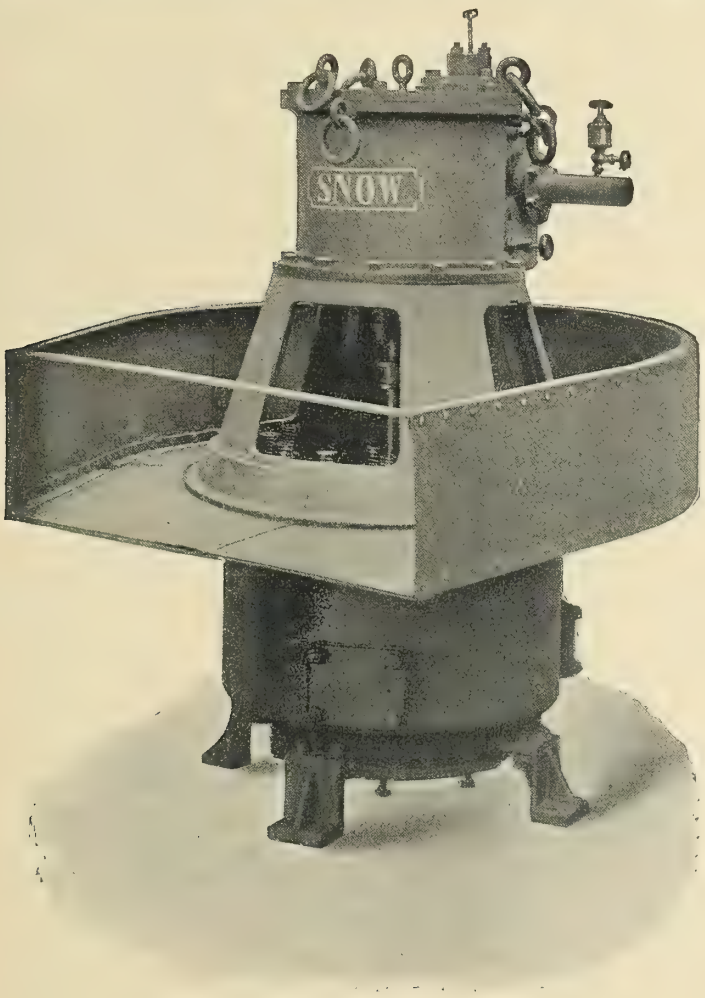


ROSS FEED WATER FILTER.

Snow Steam Wrecking Pump.

The illustration herewith shows a new vertical wrecking pump built by the Snow Steam Pump Works for the Merritt Wrecking Co., of New York. It has been designed with three points in view, viz: That there should be no flimsy projections which might be easily broken off, that the pump should be light and yet highly serviceable when doing maximum work, and that it should occupy the least space consistent with accessibility and ease of operation. The pump rests on four stout feet bolted to the pump cylinder casting, the feet being provided with holes for bolting the pump to the supporting surface. Directly on the bottom the suction nozzle is placed, the diameter in this pump being 16 in. The suction valve deck is cast in the bottom of

the pump cylinder, made light and strongly ribbed to the cylinder barrel. In this deck the suction valve seats are screwed on a taper and have a bearing on the under side of a flange which is turned on the top of each seat, so that a gasket can be interposed between the seat flange and the deck, keeping the salt water from the threads. The valves are soft rubber, each covered with a brass plate, on top of which is the spring, so that an even bearing over the valve is secured. There are also valve guards in place. The pump contains eighteen suction and eighteen bucket valves giving a total water way through each set of 255 sq. in. or 35.5 per cent. of the bucket area. The bucket is cast iron, ribbed, and is lined on its periphery with brass, water grooved. It works in a heavy removable sleeve which is secured to the cylinder with bronze studs. The yoke between the steam and water cylinders is of cast iron made thus: A ring is cast around the upper edge of the pump cylinder and a corresponding recess is machined on the inside surface of the bottom end of the yoke, leaving an internally projecting ring around the bottom edge of the yoke. This ring and the ring around the top of the cylinder are cut away partially so that the remaining sections of the ring on the yoke pass through the cuts made in the ring on the cylinder. When so entered, the yoke can be turned around until the projections come opposite each other, and are then keyed vertically in place, the keys pulling the yoke down on conical surfaces machined on each. These center the yoke on the pump cylinder in such a manner that the yoke can be removed easily at any time by simply driving out the brass keys and tapping the yoke lightly. As an extra precaution against the loosening of the yoke they are bolted together by brass tap bolts which pass through clearance holes in the yoke and are tapped into the ring projections on the cylinder. The upper end of the yoke has an internal flange which is bolted to the steam cylinder and mechanically centered on a centering fit. The steam cylinder is of cast iron with the lower head cast in. A bushed valve chest is cast on the side of the cylinder and has double ports leading to each end of the cylinder arranged similarly to those on a duplex direct-acting pump, and having a cushion valve interrupting communication between the two ports at each end of the cylinder. These cushion valves when slightly opened cause the reciprocating parts to come to rest slowly and thus permit the valves to almost seat before reversal, thus permitting them to seat noiselessly at the reversal. With these cushion valves a much higher speed is said to be possible than on pumps which have not got them. The main distribution valve is of the piston type, fitted with spring rings. This piston valve is extended at both ends to form supplementary pistons by which the main valve is moved. The auxiliary valve is of the rotary type and is so designed that when it uncovers one chest port to the steam it uncovers the other to the exhaust, and causes the reversal of the main valve. The bonnet through which the auxiliary valve stem passes is turned in towards the center of the pump inside of the yoke. A lever attached to the end of the auxiliary stem carries the tappet rod which passes through a tappet block attached to the spool lever, which in turn is fulcrumed on the inside of the yoke. Thus when the spool which is keyed to the piston rod approaches its extreme positions, the spool lever block comes in contact with the tappets and causes the reversal of the main valve, thereby reversing the main piston. Pumps of this design are now made by the Snow Steam Pump Works, Buffalo, N. Y.



SNOW STEAM WRECKING PUMP.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.
S. W. ANNESS, Philadelphia, Pa., The Bourse.

Western Representatives.
L. L. CLINE, Detroit, Mich., 47 Hodges Building.
B. M. GARDNER, Chicago, Ill., 1142 Monadnock Block.

Traveling Representatives.
E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:
Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

IT has often been observed that individuals possess talents, which, though latent for many years, may suddenly become sensible under the stress of necessity or the opportunity of circumstance. We are reminded of this by reading the letter of Andrew Carnegie, recently published in the Iron Trade Review, and which will be found upon another page. This successful manufacturer had long been known as a capitalist, and philanthropist, and now he unexpectedly appears on the stage of publicity as a humorist. His humor smacks of the land of his birth, for it is indeed dry and deep, not apparent so much to the casual reader as to any one understanding the things of which he writes. His letter opens, in an odd mixture of philanthropy and humor with a call of attention to "the field which is open for a first-class shipbuilding yard upon the Hudson, East River, or lower bay near New York." It was surely the essence of great heartedness to call the attention of the poor benighted shipbuilders of New York to the opportunity which they wot not of. We can picture that grand old man of shipbuilding, William H. Webb, reading the paragraph with a snort, or the Roach interests eagerly jotting down the item in their note books, or perhaps Lewis Nixon smiling softly as he placed the letter in his safe. Mr. Carnegie is correct indeed that there is a field for a first-class yard near New York; yes, acres of them. But we are minded of the old picture puzzles which, to fit the case might read: Here is a first-class shipyard—find the ships? A shipyard without ships is just like a freighter without freight—it doesn't pay. But Mr. Carnegie gives specific reasons why New York is the best location for a shipyard. It could get repair work there, he says. It could if some one else did not get it away. The present facilities in New York are good for all repairs that the foreign ship owner is likely to have executed here. In fact we know of several shops which would like to see a considerable increase in the present amount of repair work, domestic or foreign, rather than any increase in facilities, which tend to cut down the profits that Mr. Carnegie refers to. Certainly he would not argue that the addition of another large competitive shop would increase profits. A dry dock as part of the equipment also would be in his opinion highly profitable. There is, surely need of a large dry dock in New York harbor, but the profit to be made out of it by private ownership is another question. There is probably a good profit in the present dry docks, for they are practically under one management. The addition of another commercial dock would mean either a division of profits, a cutting of prices, or a combine which would probably put prices above what the foreigner would pay. Now the third proposition of Mr. Carnegie is that steel, in the near future, will be carried from Pittsburg to New York for one dollar a ton, via the Erie Canal. We have not at hand the exact figures on freights to the various Atlantic coast yards, but there is little doubt that freight arrangements would speedily be made by the railroads for all points on the seaboard where yards are now located, which would offset any advantages the special route named offers. However, the fact is there are several men engaged in shipbuilding and marine engineering in and near New York whose judgment in such matters ought to weigh more than the opinion of any outsider. They would very speedily organize the necessary financial equipment for such a yard, but we are sorry to admit that in the present state of affairs such a yard is not needed. Even were the rightful amount of business being done in our seacoast yards would New York be a better point than a location further south? This is very doubtful. Land here would be much more valuable, and the cost of unskilled labor would be an addition of at least 100 per cent. in that item alone, besides the harbor facilities bear no com-

parison with what can be obtained elsewhere. Mr. Carnegie again displays his humor in the statement that, "seaboard yards are so usefully occupied with domestic business that they cannot give foreign business proper attention." This cannot be taken seriously. No doubt the coast builders are, many of them, very busy, but that they are unable to pay attention to prospective orders is not at all so. We were under the impression that there is a yard at Sparrows Point, as well located and equipped as any yard of its size anywhere, in which not an anvil has sounded for years. Or going further down the coast we find the yard on the James river with an equipment magnificent in every sense of the word; a yard indeed which has few equals the world over, and which could easily find room for half a dozen liners if a purchaser could be found. It was only the other day that the departure of Mr. Cramp, representing the Delaware river interests, for Europe with the avowed purpose of securing a share of the great Russian Naval appropriation was noted in the press. Supposing himself the owner of such a New York yard as he describes, Mr. Carnegie declares: "there would be no warships or Atlantic liners open for bids in any part of the world," that his yard would not have something to say about. Very true, but the shipyard might bid and possibly not get work. We believe Mr. Carnegie has had an experience of this sort with the United States Government in the matter of armor plate. Apart from the question of location there are serious statements in Mr. Carnegie's letter regarding the possibility of this country resuming its rightful position as a maritime nation, and a builder of ships. What has happened in the steel rail, the locomotive, and the bridge business, for examples, will just as surely come in the shipbuilding line. It has not come yet, however, and the efforts of those who have the interests of this branch of trade at heart would do more good in extending the operations of those already in the business rather than in causing the investment of capital in disappointing schemes. Mr. Carnegie has grown rich under a system of protection, which does not exist for the shipowner in the foreign trade. We expect to see the day when the present number of yards will be increased many fold, but before this comes there will have to be adopted by the Government such measures as will induce American capital to invest in the ownership and management of steam vessels. A yard started to build ships for foreigners only would be a perilous venture, for the backbone of any nation's yards is that nation's vessels.

OUR English contemporaries announce that the Hon. Charles Parsons has designed a new form of steam turbine which he is able to reverse. The ability to go astern in the new turbine is secured by a valve arrangement whereby the live steam may be made to flow in either direction, with a necessary modification in the shape of the blades. In the "Turbinia" there was power enough to drive the vessel at 32 knots ahead and only 10 knots astern. Some were of the opinion that 10 knots speed astern was sufficient. That depends! Suppose two vessels approaching a common point and that before reaching this, even for an infinitesimally small distance, both should go astern, even at the rate of two knots, it is manifest a collision could not occur. A speed of 30 knots astern would not make the collision less possible. The elements of time and distance, however, are of vital importance to the practical navigator. In a fog, or emergency, the promptness with which ahead motion of the vessel could be changed to astern is everything. Experiment has proved this change of direction cannot be made in less distance than four or five lengths from the moment of the reversal of the engines, provided, too, that as much power is available for the astern as the ahead motion, and this is irrespective of the speed at which the vessel is moving. The efficiency astern would be less than the ahead. The time of reversal of motion would, of course, depend upon the speed at which the vessel was moving. A vessel is able to stop and gather sternway when going full speed ahead quicker than it can attain full speed ahead from a condition of rest. Ahead the hydraulic resistance alone opposes its motion, while, when the direction is reversed, this resistance is additional to the sternward propulsive power. With less power for going astern than ahead, such as in the "Turbinia," or with more, as in the case of, say, an Atlantic liner going half-speed ahead, the results would be correspondingly changed. It will thus be seen that it is very necessary to have at least as much power to go astern as ahead, if you want to stop quickly. The "Turbinia," in addition to being handicapped in manoeuvring capability, was obliged to carry an independent reversing turbine; a dead weight going ahead.

Andrew Carnegie on the Shipbuilding Industry of the United States.

Writing from Cannes, France, Andrew Carnegie, the steel maker, expresses his views regarding the United States shipbuilding industry in a letter to the "Iron Trade Review," of Cleveland, thus:

"May I call attention, through your columns, to the field which is open for a first-class shipbuilding yard upon the Hudson, East river or lower bay, near New York?

"The prices paid for steel by British and German shipyards are so much higher than shipbuilders in New York would be required to pay that the difference would make, in itself, an excellent profit. Plates are worth about $22 or $23 a ton in New York. The quoted price at Glasgow is nearly $30. Other prices are in proportion, and all the woodwork of ships is also much cheaper with us. If a yard were built today with the newest appliances, the total cost of labor, even at much higher wages, would be less than in any shipyard I know of, either in Great Britain or Germany.

"I name near New York as the best for several reasons:

"First. A shipyard there would get repair work, which is always profitable.

"Second. A drydock could be part of the equipment, which would also be highly profitable.

"Third. Two years hence the cost of transport upon steel delivered at the shipyard at New York from Pittsburg, the cheapest market for steel in the world, will not exceed $1 a ton, via Conneaut and the deepened Erie Canal.

"Indeed, it will be less, since it will cost nothing to send steel to Conneaut in cars which otherwise must return to the lake empty for ore. The present seaboard shipyards are so usefully occupied with domestic business that they cannot give foreign business proper attention. The New York yard should be constructed on a larger scale and with special reference to the foreign demand.

"I am satisfied that the United States can readily regain the supremacy in shipbuilding it had when wooden ships were in vogue. It only needs an enterprising western shipbuilding concern to establish a yard near New York and manage it with the skill and energy which have characterized those on the lakes. This is the only prominent department of manufacturing in which our country is behind, and it is one in which it easily can obtain front rank. It would justify steel manufacturers to guarantee to such a shipbuilding concern a continuance of the present extremely low rates upon steel for a term of years, and also that steel of all kinds and armor and guns should always be furnished at the lowest price paid by European shipbuilders. But there is nothing to fear from the prices of steel, for these henceforth are to rule lower in our country than in any country of Europe. It will not be long before a large portion of its steel supply must be drawn by Europe from the United States.

"If I were a younger man, or rather, if I did not belong to a concern so enterprising as to employ all my capital and give me a pleasurable occupation watching over its progress and success, I should be greatly inclined to enter upon the building of ships somewhere near New York harbor. There would be no warships or Atlantic liners open for bids in any part of the world which the New York yard would not have something to say about. Every needed element is present for regaining our supremacy as the principal shipbuilding country. Surely some one of the successful lake concerns will consider the advisability of establishing a branch yard near New York—a branch which I predict would very soon grow to many times the capacity of the original works, and give a much higher return upon capital, besides rendering its originator famous. ANDREW CARNEGIE."

MISHAPS AT SEA.

Salvage Work on the S.S. Rosedale.

An exceedingly skilful salvage job was successfully undertaken in the case of the Lake steamer Rosedale. Her dimensions are: Length over all, 254 ft.; beam, 35 ft., and depth, 21 ft., with a gross tonnage of 1,507 tons.

She was bound down Lake Ontario with a cargo of 65,000 bushels of wheat from Fort William to Prescott, when she stranded on the Charity shoal. Wrecking outfits were at once sent to the vessel and with the aid of powerful pumps she was floated off the shoal. She commenced to fill rapidly, however, and it was considered best to tow her back onto the shoal rather than take chances of her sinking in deep water. Later, work on the vessel was stopped as the underwriters believed it would not be possible to get her afloat. The Donnelly Salvage and Wrecking Co. of Kingston, Ont., then got permission from the various insurance companies to attempt to save the vessel. This company loaded its tools and coal on a schooner and got to the wreck at midnight on Sunday, December 12. Eight pumps were put aboard the Rosedale including three grain pumps to throw out the wet cargo. These pumps were connected up to the boilers on the schooner and kept continuously at work.

The Rosedale drew 16 ft. when loaded, and when on the shoal she drew 17 ft. forward and 13 ft. aft. She was fitted with a water bottom 3 ft. deep, and in many places the bottom was forced up through the inside tank tops, as the shoal was covered with boulders. One of the rents was 40 ft. long, though not very wide. A gale of wind and heavy sea interfered considerably with the work, but by Tuesday the grain was pretty well cleared away from the tank tops. Bags filled with cement were then sent down by divers and laid athwartships over the rents in the tank tops, and over these bags 2 in. wooden platforms were laid and shored down from the deck above. The lengths for the shores were found by the divers by using movable wooden battens. Scrap iron was used to sink the platforms in position. Meanwhile the engine and boiler rooms of the vessel were pumped out and steam raised in her boilers, and all the steam pumps taken aboard were set at work. On Wednesday evening the Rosedale floated and was towed 15 miles and then allowed to sink on Hinchley's flats, opposite to Cape Vincent, so that the wreckers, who had been at work without intermission even for sleep for five days, were enabled to take a needed rest. The following day she was towed to Kingston. An examination in dry dock showed that for over 200 ft. her outside bottom was all gone and the inner bottom was broken through in 33 places. The estimate of damage was $35,000.

The Rosedale was built in 1888 at Sunderland, England, for the St. Lawrence and Chicago Shipping Co. She was insured through Buffalo parties for $75,000 and the cargo had been insured in Chicago for $66,000. The engraving shows her arrival at Kingston in charge of the wrecking crew.

Shaft Breakages en Voyage.

Cases of broken shafts have been unusually numerous of late in the Atlantic trade. These have not been confined to tramps or vessels in poor condition, but several recent mishaps occurred to as fine vessels as are in the transatlantic trade.

The French liner La Champagne broke her shaft when out five days from Havre, and after drifting about for days she was sighted by the Warren Line steamship Roman, and taken in tow, reaching Halifax on February 27. After the mishap and when the engineers of the "La Champagne" had reported there was no possibility of effecting any repairs a boat's crew left the vessel to get in the track of vessels and

report the breakdown. This boat was in charge of Officer George Unsworth, and after several days of suffering and exposure, it was picked up by the Holland-America liner Rotterdam, bound for New York. The "La Champagne" had a large passenger list.

The American liner Paris, which sailed from New York for Southampton March 2, broke her starboard outboard shaft when out about 24 hours. There was fair weather and smooth seas, and with the port propeller alone the "Paris" made good headway, her daily runs ranging from 280 to 315 knots. The engines of the "Paris" are fitted with controlling gear which automatically slows down the engines when the speed rises above the normal, and this gear effectually prevented damage to the engines when the break occurred. The shaft was a new one of nickel steel, which had only recently been fitted to the vessel. The breakdown caused the liner to miss a trip.

A tow of 1,000 miles was successfully accomplished by the oil tank steamer Duffield which picked up the freight steamer Osborne in mid-ocean March 14. Two days before, the "Osborne" broke her tail shaft. She was on a voyage from London to Philadelphia under charter to the Atlantic Transport line with a general cargo. The "Duffield" was also bound west on the same course. When the "Duffield" agreed to tow the disabled steamer it was decided to try and reach Philadelphia, but bad weather caused the masters to steer for Halifax, which was reached March 20.

On March 7 the Cunard liner Catalonia, on the Boston route, was towed into Halifax by the oil tank steamer Delaware. She had left Queenstown February 23 for Boston, and when about six days out her crank shaft broke and she was helpless. For about two days she was adrift, until the tank steamer Delaware sighted her and towed her about 500 miles to Halifax. There were eighty-five passengers on the Cunarder.

The German steamer Marie Rickmers, bound from Bremen for Baltimore, was picked up at sea last month by the steamer Alpha and towed to Halifax. The breaking of the propeller shaft disabled the "Marie Rickmers." She is a new steamer of about 4,500 tons.

LAKE STEAMER ROSEDALE REACHING PORT AFTER THE STRANDING ON CHARITY SHOAL.

Destructive Fires on Vessels.

On the arrival of the steamer Flowergate at Boston February 27, with the passengers and part of the crew of the British steamer Legislator, a fearful story of fire at sea was related. The "Legislator" had left Liverpool for Central American ports on February 13, with a mixed cargo containing a lot of chemicals. When about 700 miles west of the Azores an explosion, followed by an outburst of flames, occurred in the forehold. The flames spread very rapidly, consuming all the woodwork in the forward part of the vessel and only stopping at the fire room bulkhead. Attempts were made by some of the crew to get out the boats, but this resulted only in the loss of several lives, as a tremendous sea was running. After about three days, during which the fire continued to burn in the holds, the "Flowergate" came up and took off those on board the "Legislator" in her boats. Many of them had been severely burned, though they had had medical attention from a Dr. Gordon Mortimer who, with his wife, were passengers aboard the burned ship. The "Legislator" is supposed to have sunk soon after she was abandoned.

Fire destroyed the Memphis and Vicksburg Packet City of Savannah while she was at her Memphis landing March 9. When the fire started the boat was about to leave with a large cargo and several passengers. The flames were first noticed on the upper deck in the vicinity of the smoke pipes. Several companies of the city fire department responded and the vessel was speedily flooded with water and sank to the bottom, but not before her upper works were destroyed. The vessel was about eight years old, having been built at Howard's Ship Yard at Jeffersonville, Ind. She was a stern wheeler, 190 ft. long; 32 ft. beam, and with 5 1-2 ft. depth of hold. She was valued at $25,000, and insured for $14,000.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—VIII.

BY WM. BAXTER, JR.

In the diagrams of motors, Figs. 27 to 33, three different kinds of armatures are shown; the ring, the disc and the drum. The principle of winding is the same in all of them, although judging by outward appearances there would seem to be no similarity between the ring and the drum winding. The object sought after in each case is to so arrange the wire and the connections between it and the commutator that at all times the current will flow in the same direction through all the wires on each half of the surface of the armature presented to the opposite pole faces, but the direction in one-half to be opposed to that in the other; that is, if on the side facing the N pole the current flows to the commutator end, on the side facing the S pole it must flow away from the commutator end. The manner in which this is accomplished in the ring armature has already been

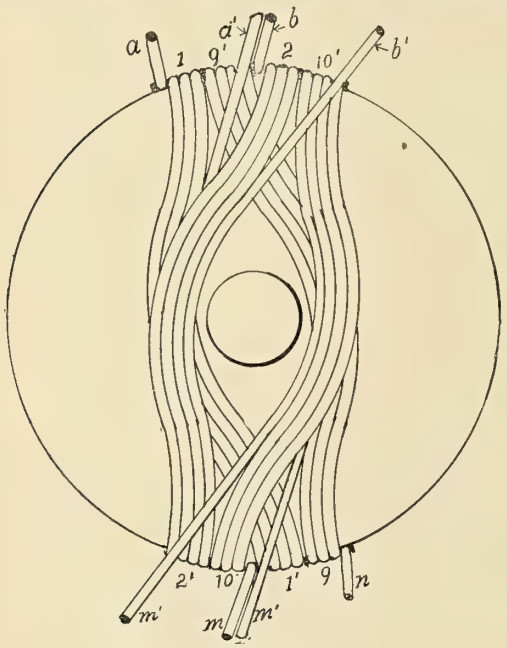


FIG. 42.

explained, and Fig. 40, an illustration of a ring armature, will help to make this matter more clear. This cut shows the back end of the armature and thus clearly reveals the manner in which the wire is wound around the rim of the ring. The surface of the armature is divided into as many parts as there are segments in the commutator, and in each one of these divisions a certain number of turns of wire is wound, the number depending upon the size of the machine, the pressure it is to develop, etc. The ends of the adjoining sections of wire, or coils, as they are called, are united, and connected with a commutator segment, thus the effect is the same as if the whole armature were wound with a single piece of wire with loops carried out at the turns that form the terminals of the coils, and these loops were connected with the commutator segments. It is evident that with such a winding if the commutator brushes rest on opposite sides of the commutator on a diameter at right angles to the center line through the pole pieces that the current on entering the armature will divide, one-half following each half of the ring and coming together at the opposite side. It is also evident that these two currents will traverse the halves of the wire opposite the pole faces, and that on each side the direction of the current in every turn of wire will be the same, and that the current as a whole will flow in opposite directions on the two sides of the armature.

In the disc armature the winding is the same as in the ring, the only difference between these two styles of armature being in the shape of the core. The drum winding, however, has to be somewhat modified owing to the fact that as there is no open space through the center of the armature, a place must be found upon the outside surface for that part of the

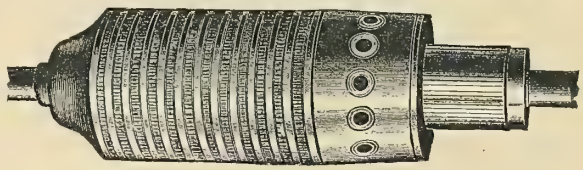


FIG. 41.

coils that in the ring passes along the inner surface of the rim. Fig. 41 shows the general appearance of a drum armature, and Fig. 42 will help to make clear the manner in which the coils are wound and connected with the commutator. As in this type of armature, both sides of the coil have to be placed upon the outer surface, the commutator segments cover twice as long an arc for the same width of coil as in the ring, and this has led many students to suppose that the number of divisions of the commutator is reduced to one-half; but such is not the case, for although the widening of the commutator segments reduces their number to one-half the armature coils are also reduced to one-half owing to the fact that each coil occupies two positions on the outer surface. This can readily be understood from Fig. 42, in which coil 1 occupies its full width on opposite sides of the circumference, and this is also the case with coil 2 and coils 9 and 10. The part of coil 1 on the upper side of the figure may be regarded as corresponding to the part of a coil in a ring armature that fills a position on the outside of the rim, and may be called the front of the coil. In the same way the part filling the position marked 1′ may be called the back of the coil, and corresponds to the part that passes through the center of the ring armature. The part marked 9′ is the back of coil 9 and in the ring would pass along the inner surface of the rim, the same as side 1′ of 1. Coil 2 is separated from 1 by 9′, but as 9′ fills this space because there is no other position for it, 2 can be regarded as the coil that adjoins 1 just as much as two coils side by side in the ring armature. If end a′ of coil 1 is connected with end b of coil 2 the relation of the two coils will be the same as in the ring winding. If the

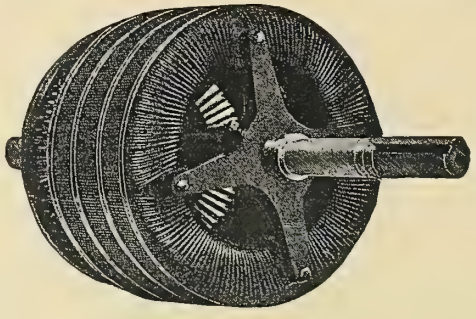


FIG. 40.

armature were completely wound coil 3 would adjoin 10′ and would be followed by 11′ and then 4, and so on around to 9. If a current were passed into the wires a′ b it would follow through to a′ on one side and b′ on the other, and if all the coils were wound

and connected with each other in the manner just described the path from b′ would be through coils 3, 4, 5, 6, 7, 8, 9 to wire n′, and from wire a′ through all the remaining coils to wire m. Thus it will be seen that in all the coils to the right of wires a′ b′ and n′ m the direction of the current would be the

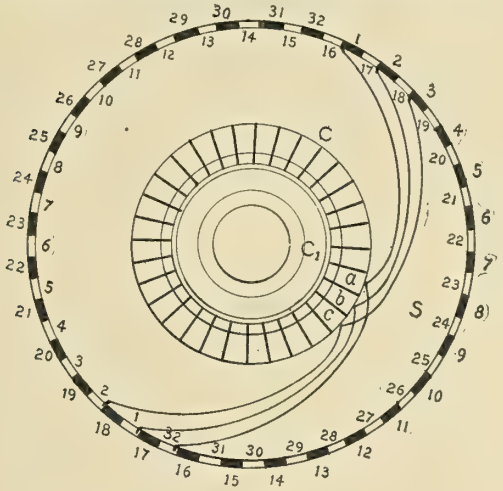


FIG. 43.

same, and that this would also be true of all the coils to the left, but on (the) two side the direction of current would be opposite.

In Fig. 42 the two ends of the coils are shown coming out on the same side of the armature, this being done because it simplifies the winding, specially the connection of the ends with the commutator. This is the almost universal practice, but sometimes the ends are brought out on the opposite sides. When the latter course is followed it is for the purpose of changing the position of the brushes upon the commutator. With the simple winding of figure 42 the brushes have to be placed at positions midway between the poles, that is, if the ends of the coils are connected with commutator segments directly in line with them, which is the universal custom. Sometimes the shape of the machine is such that if the brushes are placed opposite the interpolar spaces they cannot be got at very easily, and then it becomes desirable to change their position. This can only be

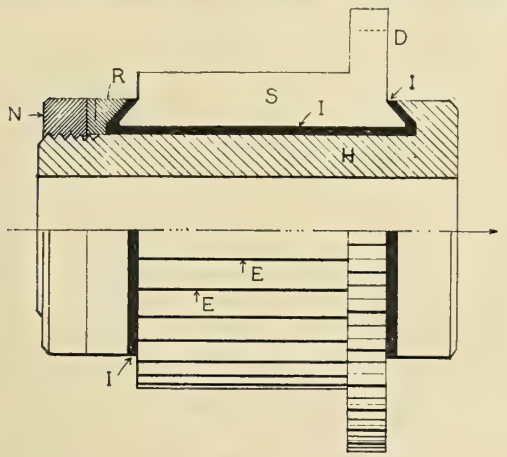


FIG. 44.

accomplished by connecting the wires with segments not in line with them. When this is done it is not advisable to carry the end coming from the back of the coil across to the opposite side of the armature, for from this position it would have to be carried back again; it is, therefore, better to resort to the arrangement shown in Fig. 43. If this figure were wound with both ends of the coil coming out on the same side as in Fig. 42, the junction of wires a′ and b of coils 1 and 2 would be connected with segment n of the commutator C, but as the object is to shift the connection around the circle to segment b, a considerable amount of wire can be saved by running the end a′ of coil 1 from the lower side of the armature to segment b, and the end b of coil 2 from the upper side to the same segment. All the other connections are made in the same order, and as a result when the commutator is fully connected the wires leading from it to the armature coils are twisted around in a manner that appears quite confusing to a novice, but from a study of these two figures it will be found that it is not in the least complicated.

The most prominent machine in which the connection of Fig. 43 is used is the Edison. The only thing to guard against in connecting such armatures is to not get hold of the wrong ends. In the ordinary winding of Fig. 42 such mistakes cannot very well be made as the ends that are to connect with the same commutator segment are side by side and cannot easily be displaced. In Fig. 43 the front sides of the coils are made black and the backs white so as to show the method of connection more clearly. For the same reason the front sides are numbered on the outside of the circle and the backs on the inside. To find

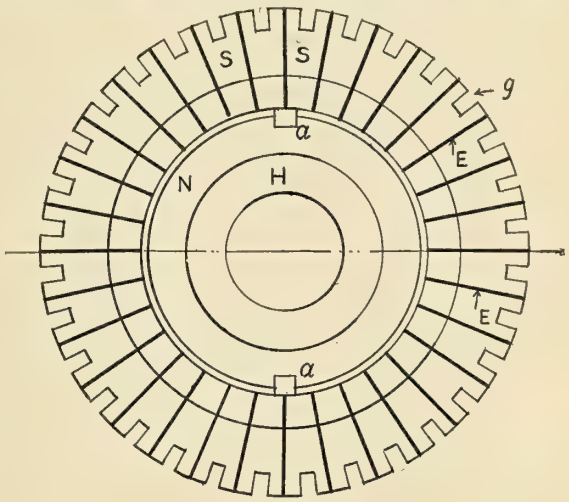


FIG. 45.

the two ends of each coil in an armature that is to be connected in this manner the best course to pursue is to connect one end with a battery having in circuit with it a bell, then the other end of the wire is connected with the ends on the opposite side of the armature until one is found through which the bell will ring, and this is the other end of the coil. After the ends are found they should be numbered, and when they are all numbered the connection will be very simple.

To avoid confusion it may be well to say that in Fig. 42 the number of coils is 16 and in Fig. 43 it is 32.

Figs. 44 and 45 show the construction of the commutator, the first being a side view, with the upper half in section, and the last an end view. The segments are marked S and as will be seen they are held in place, on the hub H, by means of the nut N and ring R. In addition to being securely held they are metallically separated, or insulated from each other, and from the hub, by the insulations I and E shown in black. This insulation is generally made of mica, as this material is a very good electric insulator and is also strong mechanically. The ring R is provided so that when the nut N is turned around it will not drag the segments out of place. R is held by a feather so that it cannot revolve. The nut N

is sometimes made with flat faces, on opposite sides, so that it may be turned by a wrench and sometimes with slots, as shown at aa, in which the end of a spanner may engage. The ends of the wire coils of the armature are fastened to the part D, as a rule, being soldered into grooves shown at g in Fig. 45. but they are also secured by means of screws. Either method is good with good workmanship, but both are bad with poor workmanship.

QUERIES AND ANSWERS.

If J. W. B. and O. R. will send their full names and addresses their queries will receive attention. All communications in this department of Marine Engineering are considered confidential, and any correspondent who fails to send his correct name and address with a question need not expect any consideration.

Q.—H. D. B. California.

A.—You will find the data concerning the battleships of the United States Navy on Page 15 of our March issue, and the data concerning foreign navies you ask for on Page 17 of our May, 1897, issue.

Q.—Should the water be fed into a Scotch boiler in the steam or water space? T. P.

A.—Into the water space below the water line. If you feed it into the steam space the chances are the greater part of it will be carried over into the engines. The correct point at which to admit the feed is a matter about which differences of opinion exist. A distributing pipe fitted above the waterline is likely to be shattered in a very short time if the feed is intermittent.

Q.—What is meant by the co-efficient of fineness of a vessel? J. F. C.

A.—The fractional part which the volume of the immersed portion of a vessel bears to the volume of a rectangular block of the same length, breadth and depth. The formula reads:

$$\text{Co-efficient of fineness} = \frac{D \times 35}{L \times B \times W},$$

D being the displacement of the vessel in tons of 35 cubic feet of sea water to the ton; L, the length between perpendiculars in feet; B, the extreme breadth of beam in feet; and W, the mean draught in feet, less the depth of keel, if the vessel is fitted with an outside keel. Fast ships with fine lines have a co-efficient of fineness of about .55, ordinary merchant steamers .68, and slow freight vessels about 75.

Q.—What is the best material for a screw propeller? W.

A.—That depends on a number of conditions, and as you do not give details, only a general reply can be given. Cast iron is cheaper than other materials and can be more readily obtained. It is easily machined, but such propellers are heavy and cumbrous. An advantage of this material is that should the propeller come in contact with a dock wall or other immovable body, the blades will break and prevent serious damage to the propelling machinery. Steel or bronze would only twist out of shape. Cast iron and steel propellers, of course, are liable to severe corrosion, while manganese bronze is not so affected. Bronze propellers are also made with very thin accurately shaped blades giving increased efficiency.

The Old Dominion line has under consideration the construction of a new steamer upon the lines of the "Princess Anne," which has proved herself to be a remarkably fine and economical boat.

The side wheel steamboat Grand Republic, said to be the largest on the Mississippi River, was burned to the water's edge while in winter quarters near the mouth of the River des Peres, March 13. The captain and his party were aboard asleep when the fire broke out in the galley, and the flames spread so rapidly that they had difficulty in getting ashore without injury. The vessel was built in 1878 at Pittsburg, and cost about $100,000. She belonged originally to the Helena and New Orleans Transportation Company, and was used for carrying cotton. For several years, however, she had been used exclusively for the excursion trade, having a license to carry 3,500 passengers. Her dimensions were: Length, 265 ft.; beam, 50 ft. She had four decks. She was owned by the Columbia Excursion Co., and was insured for $30,000.

ENGINEERS' DICTIONARY.—IV.

Bilge Pump.—A pump for the special purpose of freeing the bilge of water. In some cases such pumps are attached to the main engine, but more commonly in modern practice they are independent and are used only as needed.

Blow down or *blow off* (to).—A verb signifying the operation of discharging water from the boiler through the bottom or surface blow.

Blow through (to).—A verb signifying the operation of driving all air and water out of a steam cylinder and of heating it to the working temperature by allowing steam from the boiler to blow through the throttle into the cylinder, and out through the relief valves or drains.

Boiler.—In the general sense, any receptacle in which steam is generated by the application of heat. To this end a boiler must contain three fundamental features: A place for the fire, a place for the water and a partition between them. The great variety of boilers arises from the different forms which these features take, and the different manner in which they are arranged. The keynote of the development of steam boilers from the earliest forms is contained in the word *sub-division*; sub-division of the hot gases and of the water, so that no particle of either shall be very far from the partition or *heating-surface*. If in addition to this sub-division, provision is made for a definite flow of the hot gas along one side of the heating surface and of the water along the other in the opposite direction, the conditions for the most efficient transfer of the heat of the former through the surface into the latter will be fulfilled. In modern boilers the principle of sub-division has been carried to a high degree of development, but the conditions for proper circulation are but imperfectly fulfilled. The sub-division is obtained by the use of a large number of tubes or tubular elements surrounded by a shell or casing. The first and chief classification of the general term *boiler* is made according to the relation of the water and hot gas to these tubular elements. If the gas is led through the inside and the water is on the outside, the arrangement is known as a *fire-tube* boiler. If, on the contrary, the gas is on the outside and the water circulates through the inside, the arrangement constitutes a *water-tube* boiler. Of the great variety of boilers in use we shall here only refer to a few cases typical of marine practice.

RETURN FIRE TUBULAR OR SCOTCH BOILER.

Fig. 6. This consists essentially of an all inclusive cylindrical steel *shell* containing one or more cylindrical *furnaces*, usually corrugated circumferentially for strength, opening into *combustion chambers* at the back end, from which a large number of small *tubes* lead again to the front end or *head* of the boiler. The *grates* are placed at about the center of the height of the furnace, and the fire and hot gases occupy the upper part of the furnaces, the combustion chambers, and the inside of the tubes, while the water and steam fill all remaining parts of the shell, the water level being usually some 6 in. to 8 in. above the highest part of the tubes or combustion chambers. The hot gases pass from the fire on the grate bars into the combustion chamber, thence forward through the tubes and out through the *uptake* or *front-connection* to the *smoke stack* or *funnel*. Several varieties of this boiler are in common use. Thus the number of furnaces may be one, two, three, or four. They may be fitted with separate combustion chambers, or there may be one combustion chamber for all furnaces, or as is common with four furnaces, there may be two combustion chambers, one for the two furnaces on either side. Again, the boilers may be *single-ended* or *double-ended*. Fig. 6 is an example of the first. A

double-ended boiler consists of two sets of furnaces opening from either end of a shell of double length. It is evidently equivalent to a pair of single-ended boilers placed back to back, the back heads removed and the shells joined. Such boilers may also have either separate combustion chambers for each end, or a common combustion chamber for both ends. The former arrangement is to be preferred, and becomes necessary where forced draft is used.

DIRECT FIRE TUBULAR OR MODIFIED LOCOMOTIVE TYPE.

In this boiler the hot gases pass from the grates, either direct or through a combustion chamber, to the

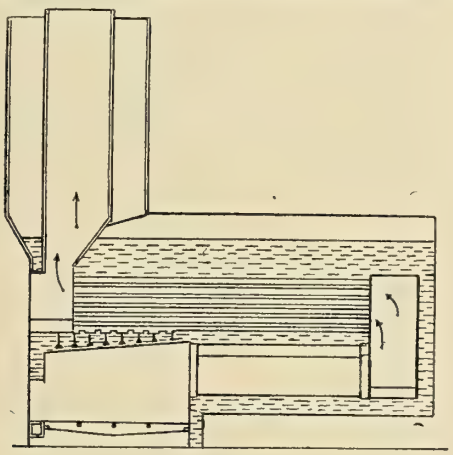


FIG. 7.

tubes which lead on to the farther end instead of back to the front. At the farther extremity is a connection or smoke box which leads to the stack. In such cases the boiler for the same power is of smaller diameter and greater length than the Scotch type, and it is readily seen that the whole arrangement is simply a mode of exchanging diameter for length. Boilers of this type, with a combustion chamber between the furnace and tube plate, are sometimes used where head room is very restricted, as on light draft gunboats or other small craft, while

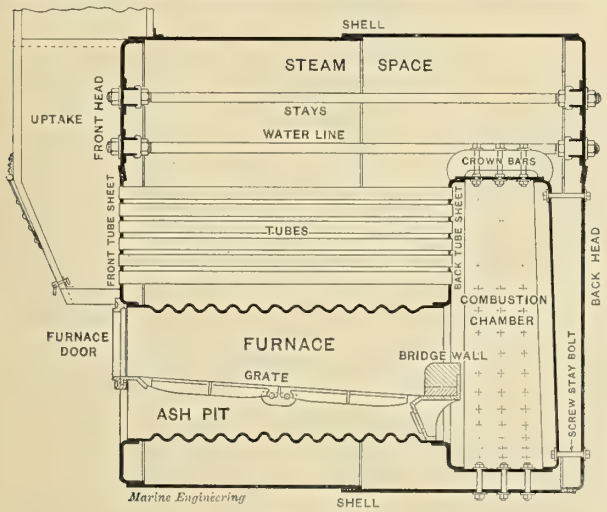


FIG. 6.

boilers of the more simple type without the combustion chamber are not infrequently met with on tugs and river craft.

FLUE AND RETURN TUBULAR OR "LEG" BOILER.

Fig. 7. In this boiler the hot gases pass from the grate through large tubes or *flues*, as they are termed, to a combustion chamber at the farther end. They then return to the front through small tubes and are led by an appropriate uptake to the stack. The furnace is of rectangular cross-section, and the front end of the boiler is modified on the sides and bottom to correspond to this form. The boiler shell surrounds the furnace on the sides leaving a narrow space between the two known as a *water leg*, whence the common name of the boiler. This form of the front end of the boiler with flat sides and rounded top is sometimes known as a *wagon top*. The remainder of the shell is known as the *barrel*. Very commonly, as shown in Fig. 7, an attachment to the shell known as a *steam chimney* surrounds the lower part of the stack, the office of which is to subject the steam to the drying and superheating effects of the gases on their way through this part of the stack. Such boilers have been much used on tug and river boats.

WATER TUBE BOILERS.

Turning now to this type, a brief mention only can be made of some of the characteristic features which are combined in the greatest imaginable variety, making possible the vast number of forms of such boilers on the market at the present time. In the engravings here shown Figs. 8, 9, 10, 11, a few typical forms are introduced to aid the description of the characteristic features. The number of actual varieties is so great as to render impracticable any comprehensive pictorial representation. Most boilers of this type have one or more cylindrical drums or chambers on top and one or more similar chambers below, the two sets of chambers being connected by sets of tubes. The feed usually enters first the upper chamber, frequently passing on its way through a coil heater in the base of the stack or top of the

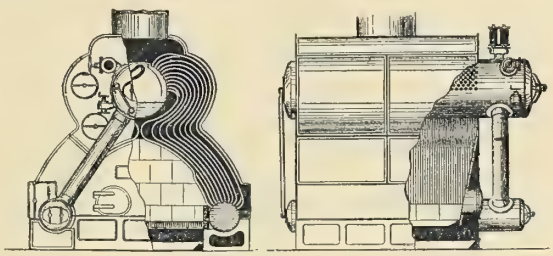


FIG. 8.

boiler. It then flows down certain of the tubes to the lower chambers. If these tubes are of extra large size and specially intended for down flow, the boiler is said to have special *down flow* or *down cast tubes* or *pipes*, as in all of those here shown. In some cases such tubes are omitted, and the feed must descend through part of the small inner tubes. In any case it then enters the lower end of the *up flow* or steam forming tubes which are surrounded by the hot gases coming from the furnace below them. During the passage of the water upwards it is partly converted into steam, and the mixture issues from the upper end of the tubes into the upper chamber. There the steam is separated and led to the engine, while the water joins that already in this chamber, and thus begins another round. In some cases the upper ends of the steam forming or delivery tubes are below the level of the water in the upper chamber, and they are then said to be *drowned* or *wet*. In other cases they are above the water level, and are said to be *dry*. In still other forms they enter at about the middle of the chamber or about the water level, and may be *wet* or *dry*, as the level varies. Figs. 8 and 9 have *dry* tubes, while in Figs. 10 and 11 the opening is near the water level. Again the tubular elements may be made in a great variety of forms. In some they are straight as in Fig. 11, in others curved as in Figs. 8, 9 and 10. In some they are continuous between chambers as in Figs. 8 and 9, while in others as Figs. 10 and 11, they are made up of lengths or of different parts with screwed

joints, elbows, returns, junction boxes, etc. In some they are expanded into the shells of the chambers, in others screwed. In some all joints are carefully protected from the direct action of the flame, in others screwed joints are freely exposed to the flame. In

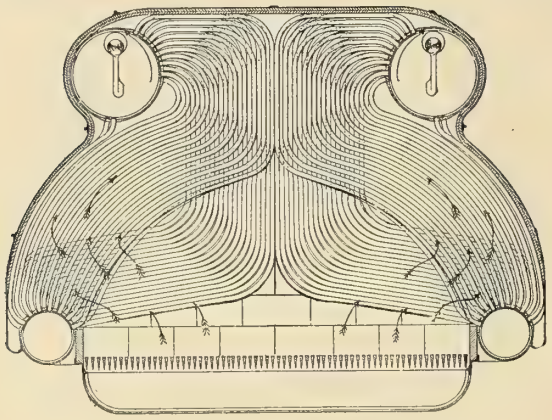


Fig. 9.

some the general direction of the tubes is nearly vertical, in others nearly horizontal, and in others bent or curved in various forms. In some types, as Fig. 11, the lower chambers are omitted, or consist merely of the lower portions of the tubes and *headers*, or members to which they are connected. In all cases the grate lies below the tubes and frequently between the lower chambers, as Figs. 8 and 9, while the whole is surrounded by a casing intended to prevent, so far as possible, the loss of heat by radiation.

RESUME:

The weight of Scotch boilers without water per square foot of heating surface is usually from 25 to 30 lbs.; of water tube boilers of the lighter types from 12 to 20 lbs. The weight of the contained water per square foot of heating surface is usually found respectively from 12 to 15 lbs., and from 1.5 to 3 lbs. It results that Scotch boilers with water will weigh from say 37 to 50 lbs. per square foot of

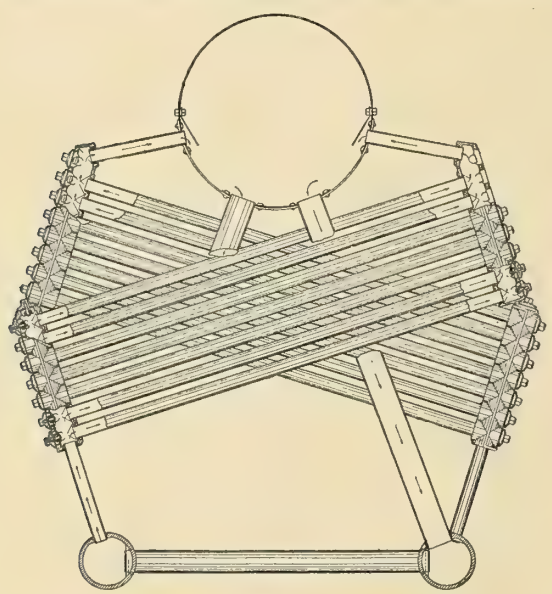


Fig. 11.

heating surface, while water tube boilers will similarly weigh from 13.5 to 23 lbs. These figures are not to be considered as giving absolute limits, but simply representative values for the lighter types. In a general comparison between water tube and Scotch boilers, the former have relative advantages in considerations relating to safety from disastrous explosion, weight, suitability for high pressures, quickness of raising steam, and ability to stand forcing. They have relative disadvantages in considerations relating to the more rigid restriction of the feed to fresh water, the necessity of greater regularity of feed, general sensitiveness to variation in the circumstances under which they are working, and to the general feeling of uncertainty as to their durability and efficiency under the conditions prevailing on deep water voyages.

Of materials for boilers, open hearth mild steel has displaced all rivals, and is used alone for shells, heads, combustion chambers and braces. Both steel and wrought iron are used for tubes. In the best practice, all longitudinal shell seams are *double-butt-strapped* and *treble-riveted*, while the circumferential seams are lapped and double or treble-riveted. Generally speaking, all flat surfaces in a boiler require special support by bracing. With cylindrical curved

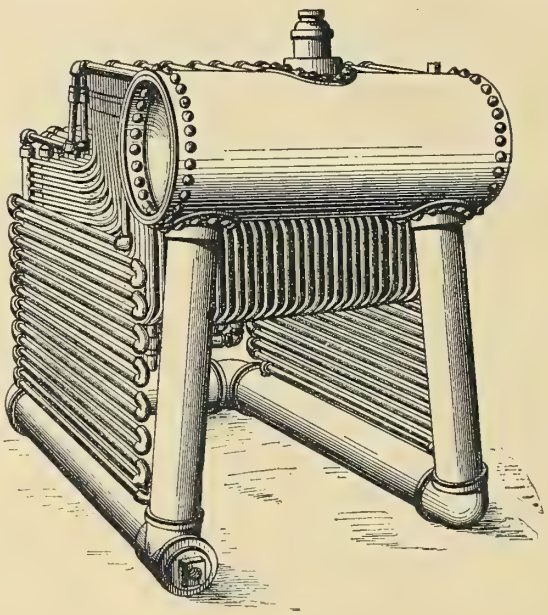


Fig. 10.

surfaces subjected to pressure on the concave side the stress is a direct tension, and may be provided for by a proper thickness of the plate. Cylindrical curved surfaces subject to pressure on the convex side are supported by stiffening bars or ribs running in a direction at right angles to the axis. Where flat plates are thick and not exposed to the direct action of the flame, as in the heads of Scotch boilers, the braces are usually spaced widely, from 12 in. to 15 in. between centers, and are relatively large. Where the plates are exposed to the flame and relatively thin, as in the combustion chambers, the braces are spaced more closely, usually about 7 in. between centers, and are relatively smaller in diameter. These latter being usually short and screwed into both plates, are called *screw stay bolts*. See Fig. 6.

Boiler Casing, *Covering* or *Lagging*.—A non-conducting covering placed around the boiler and intended to prevent the escape of heat by radiation. The material consists of some form of felt made non-combustible by special process, or, more commonly in modern practice, of some mineral material or fiber, such as magnesia covering, asbestos, or mineral wool. This covering is held in place by sheet-metal straps or bands, or in some cases by a complete sheet-metal casing.

DURING THE MONTH.

The twin screw steamer Bulgaria, 12,000 tons, for the New York freight and passenger trade of the Hamburg-American Line, was launched at the yard of Blohm and Voss, in Hamburg.

The torpedo boat McKee was launched at the yard of the Columbian Iron Works, Baltimore. She is 101 ft. 6 in. long; 12 ft. 6 in. beam, and 4 ft. 3 in. draught. With 850 I. H. P. she is expected to reach a speed of 20 knots. Her armament will include two 18-in. Whitehead torpedo tubes and a rapid-fire gun.

In connection with the shipment of horses from America the Atlantic Transport Line is about to try an experiment at the London dock by establishing stables, which will accommodate about 200 head. Here animals which have crossed the Atlantic will be stabled for a rest before reshipment to points on the continent, or anywhere else which involves a long journey. There will also be an effort made to conduct sales of horses brought to England in connection with the stables.

The steam yacht Osceola, owned by Thomas L. Watt, of the American Yacht Club, was launched March 9 from Pine's shipyard, foot of Twenty-fourth street, South Brooklyn. The "Osceola" will be enrolled in the American and Atlantic Yacht Clubs. Her guaranteed speed is 15 miles an hour. She is built of wood, is 120 ft. over all; beam, 10 ft.; depth of hold, 18 ft.; 17 ft. 6 in. draught. She is schooner rigged. The interior trimmings are of white and quartered oak. The "Osceola" is expected to be in commission during the early part of April.

The new Maine Line steamer Horatio Hall was successfully launched at Roach's shipyard, in Chester, March 23. More than 3,000 persons witnessed the launch. The steamer was christened by Mrs. Jeannette Hall Clark, daughter of Captain Horatio Hall, the New York representative of the Maine Line, after whom the steamer was named. The new vessel has a double bottom, is 31 ft. long, 48 ft. beam, 20 ft. deep, and of 3,300 tons displacement. She is to have triple expansion engines and six boilers. She is expected to attain a speed of 18 knots. She will carry 2,000 tons of freight, have 135 staterooms, and be furnished throughout with electricity. Her cost will be about $400,000.

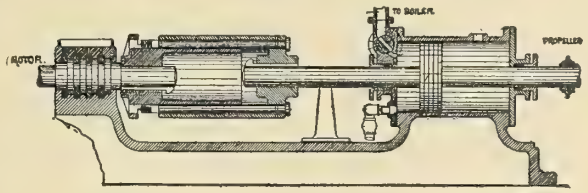
Officers Thomas G. Seagrave, George E. Beckwith and Hector R. Campbell, and twenty-four of the crew of the American Liner St. Louis, who participated in the gallant rescue of the passengers and crew of the Holland-America liner Veendam, on February 7, were presented with appropriate testimonials on March 14. Various officials of both lines, including Clement A. Griscom, president of the American Line, and General Agent of the Holland-America Line, were present. Each of the officers received a handsome silver cup and a medal, the latter from the Life Saving Benevolent Association. The men received substantial money prizes from both companies, and many expressions of recognition of their bravery were made.

The large steamer, the "Rapidan," for the American trade, was launched by Furness, Withy and Company, of West Hartlepool, England, to the order of the Chesapeake & Ohio Steamship Co. Her dimensions are: Length, over all, 490 ft.; beam, 56 ft.; depth molded, 35 ft. 6 in. She will be rigged as a four mast fore-and-aft schooner. The propelling machinery will consist of triple expansion engines, with cylinders 28 in., 46 in. and 75 in., by 54 in. and four single ended Scotch boilers, 15 ft. 6 in. dia. and 10 ft. 6 in. long, working at a pressure of 180 pounds. Accommodation for 800 head of cattle will be fitted. Her deadweight capacity will be 11,500 tons, and she will be engaged in the cargo and cattle service between London, Liverpool and Newport News, Va.

SELECTED PATENTS.

598,421. MARINE SCREW PROPULSION. *Louis Hachenberg, New York, N. Y. Filed March 21, 1896.*

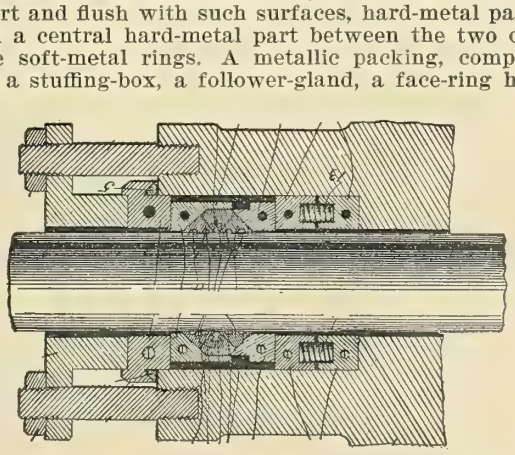
The combination with a motor-shaft, of a thrust-shaft, means intermediate of said shafts whereby they are slidably connected, a piston formed on the thrust-shaft, a cylinder in which the piston reciprocates, a supply for an elastic fluid under pressure to the cylinder, a valve for controlling the admission of fluid, and a cut-off mechanism operated by the thrust-shaft; all constructed to intermittently supply the elastic fluid to the cylinder, which fluid will main-



tain a constant equilibrium between the thrust and pressure by expansion or compression under varying conditions of thrust. The combination of a motor-shaft, a thrust-shaft, means intermediate of these shafts whereby they are slidably connected, a cylinder, a piston on the thrust-shaft adapted to reciprocate in the cylinder, a valve for admitting an elastic fluid under pressure to the forward end of the cylinder, and a cut-off operated by the thrust-shaft; there being an opening in the cylinder whereby an air-cushion may be established and a direct exhaust for the elastic fluid formed; all constructed to intermittently supply the elastic fluid to the cylinder, which fluid will maintain a constant equilibrium between the thrust and pressure by expansion or compression under varying conditions of thrust.

598,123. METALLIC PACKING. *Frederick F. Swain, Chicago, Ill. Filed August 9, 1897.*

In a metallic packing, the combination with a stuffing-box of wearing-rings mounted in such stuffing-box composed chiefly of soft metal, but having secured to their under surfaces, at suitable distances apart and flush with such surfaces, hard-metal parts, and a central hard-metal part between the two outside soft-metal rings. A metallic packing, comprising a stuffing-box, a follower-gland, a face-ring hav-



ing a shoulder supported by the follower-gland, wearing-rings having plane faces bearing upon the rod, inclined sides and a pyramidal recess, a pyramidally-shaped member bearing in such recess, reciprocating parts having inclined bearing-surfaces resting upon the rings and wearing-rings having sockets above the rod and a bearing at the inner end against the reciprocating part: whereby all of the members are supported by the rod and out of contact with the same, excepting the wearing-rings.

TRADE PUBLICATIONS.

A good deal of money can be saved by care in handling oil, and a pamphlet issued by the Burt Mfg. Co., Akron, Ohio, gives a number of testimonials showing what a large amount of money can be saved by the use of the Cross filter, manufactured by this company.

A neat catalogue has been received from the Charles F. Elmes Engineering Works, Morgan and Fulton streets, Chicago, Ill. It contains eight large pictures giving views of this company's shop and a supplement illustrating and describing a direct connected electric plant made by this company.

"Friction and Lubrication" is the latest publication of the Joseph Dixon Crucible Co., Jersey City, N. J. It is an eight page pamphlet devoted to a careful and thorough consideration of the value of pure flake graphite for lubricating purposes. Every man who is interested in the subject of lubrication should send for a copy.

A folder is received from Cole & Kuhls, foot of Twenty-fourth street, Brooklyn, N. Y., regarding their elastic seam composition. This composition is designed for calking deck seams and checks and cracks in wood in any part of a boat. A number of testimonials and names of prominent yachts show that the composition is extensively used.

Ship and yacht water-closets of five types are finely illustrated and fully described in a large well-printed eight page catalogue issued by McCambridge & Co., Ltd., 525 Cherry street, Philadelphia, Pa. These closets are in use in many of the vessels in the United States Navy and some of the best-known coasting vessels and yachts in the country.

Some very novel advertising is being done by the W. S. Haines Co., 136 South Fourth street, Philadelphia, Pa., regarding the Heintz trap, one of the latest sheets comprising a card giving an amount of information regarding the Heintz trap, and having around the border pictures of all other kinds of traps. Heintz traps are sent on 30 days' trial when desired, as explained in these cards.

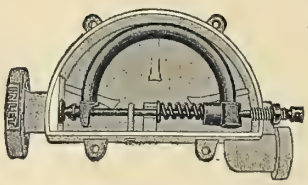
An almanac is a book that every boat finds convenient for reference, and the most complete one received this season is from the Woolsey Paint and Color Co., 100 Hudson street, Jersey City, N. J. It contains the usual information found in an almanac, with pictures and humorous matter, and a great deal of data written especially for use of marine people. Every reader will want to send to the company for a copy of the almanac, mentioning MARINE ENGINEERING.

The 1898 catalogue, issued by the Electric Gas Lighting Co., 195 Devonshire street, Boston, Mass., is a handsome one and should be in the hands of every one who uses primary batteries, electric gas lighters, etc. Several types of batteries are manufactured by this company, the best known one being the Sampson, which is very generally used for sparking purposes on gasoline launches, as well as for bell outfits and other uses where a powerful and long lived battery is needed.

Two interesting and valuable catalogues for engineers are published by William Craig, 42 Cortlandt street, New York. One relates to heating and circulating water and equalizing the temperature in steam boilers. A number of pictures illustrate the circulator and describe fully the work of this device. The other is devoted to valves and other specialties and contains more illustrations than the former and is more complete in many respects. In each catalogue are several testimonials showing the value of the device referred to.

Hot Water

saved with the "Heintz" Steam Trap—puts it where you want it, too. Works in any position—opens and closes on difference of one degree of heat—211° to 212°—smallest size discharges one gallon water a minute and not an ounce of steam wasted. Six parts besides the case—No levers, no floats, no springs. Practically nothing to wear out. Ask for Booklet "G."



William S. Haines Company,
136 South Fourth Street,
Philadelphia.

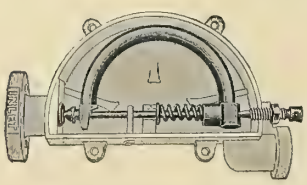
"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 9

An Extra Engineer

not needed to look after the "Heintz" Steam Trap. It's automatic, sensitive, lasts for years. Operates by expansion of sealed tube, which closes the valve as live steam enters the trap—212°: valve open at 211°. Smallest size discharges a gallon of water a minute.

Guaranteed to give best results and save coal and steam. Our Booklet "G." interesting to users. Ask for it.



William S. Haines Company,
136 South Fourth Street,
Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y 12

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO.,
JERSEY CITY, N. J.

REDUCING VALVES

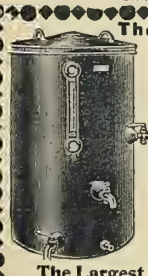
to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Catalogue Sent upon Application.

THE MASON REGULATOR CO.,
6 & 8 Oliver Street, BOSTON, MASS.



The CROSS OIL FILTER

actually reduces oil bills 50% or more. Sent on approval. Used in 17 countries. Adapted to steam vessels of every description. Send for circulars, testimonials, etc.

THE BURT MANUFACTURING CO.
AKRON, OHIO, U. S. A.
The Largest Manufacturers of Oil Filters in the World.

BUSINESS NOTES.

A Good Order for Valves.—The Cleveland Shipbuilding Co. now has under construction one of the largest carriers on the Great Lakes for Pickands, Mather & Co., Cleveland, and among other fittings has ordered twenty-five reducing valves from the Mason Regulator Co., 6 Oliver street, Boston, Mass.

Increasing Facilities.—Arthur V. Denman, who for some years has had a shop at 232 West street, New York, for selling and repairing ship locks and hardware and doing all kinds of ship work, will remove on or before May 1 to much larger quarters with better facilities at 458 East Tenth street

Demand for Yacht Closets.—The Marine Appliance Co., 36 Oliver street, Boston, Mass., has been busier this season than ever before, especially in supplying closets for yachts. Circulars regarding the various types of closets made by this company have now been published and can be had by anybody interested in the subject.

A Fine Refrigerating Plant.—Colonel Oliver H. Payne, owner of the fine yacht illustrated in the February number of Marine Engineering, has ordered a Kilbourn ice machine of large capacity from the Kilbourn Construction Co., Drexel building, Philadelphia, Pa., for the new yacht. It will be one of the most complete refrigerating plants ever built for marine use.

Food for Sea-Going Vessels.—Concentrated foods are in much demand nowadays for use at sea, especially when packed so as not to be affected by dampness. One of the most recent products of this kind is the Standard Emergency Ration, hermetically sealed in tin; "always ready; never spoils," prepared by the American Compressed Food Co., Passaic, N. J. This is a high grade food and is particularly adapted for use on yachts, steam vessels, lifeboats and elsewhere.

Yukon River Boats.—Murray & Tregurtha, foot of F street, South Boston, Mass., have just completed a boat to be shipped overland for use on the Yukon River. It is 34 ft. by 9 1-2 ft., and has twin screws with a 4 1-2 by 5 engine on each shaft. The boiler is a Tregurtha water-tube, with 41 sq. ft. of grate surface. Tubular protections cover the propellers in order to avoid accidents as much as possible.

Moved to Larger Quarters.—The large increase in the business of the Eastwood Wire Mfg. Co., Belleville, N. J., has necessitated larger quarters for its New York office, and on or before May 1, the office will be removed from 121 Liberty street to 95-97 Liberty street. The company will then be better prepared to answer all inquiries regarding valves, whistles and other steam fittings, anti-friction metal, etc. The office is in charge of Franklin Williams.

A Busy Engine Builder.—James H. Paine & Son, Park and Clayton streets, Boston, Mass., have just finished a 10 in. by 20 in. by 24 in. compound engine for the yacht being built by Pryor & Clark, for a New Yorker, and have nearly completed work on a 6 in. by 9 in. by 15 in. by 9 in. engine for the yacht which Reed Bros., of Fall River, Mass., are building for D. M. Anthony, of the same city. These orders, with many others, have kept the shops of this company particularly busy this spring.

Propeller Stern Pipe Packing.—The Mabbs hydraulic rawhide packing, manufactured by the Mabbs Hydraulic Packing Co., P. O. Box, 829, Chicago, Ill., has met with much success on the Great Lakes and elsewhere for packing propeller stern tubes, and is now being used on the seacoast and elsewhere in the country. Many of the valuable features of this packing are told in a folder recently issued and which can be had upon application to the company, together with any other information desired.

A Sheriffs Steerer.—The tug just built by the Union Dry Dock Co., Buffalo, N. Y., one of the finest steel tugs ever constructed in the country, was fitted with a steering apparatus made by the Sheriffs Mfg. Co., Milwaukee, Wis.

Portable Elevators for Wharf Use.—A device of much value for handling barrels and other packages and properly tiering them is being put on the market by the Fox Portable Elevator and Rack Co., 120 Liberty street, New York. This device can be moved to any position, and by means of a crank the packages are hoisted to their proper position and put in place without delay and with the expenditure of a minimum amount of effort.

Reliable Planimeters.—In the working out of indicator cards the planimeter is a very necessary instrument, not only to save time, but to insure accuracy. In order to supply instruments that shall be thoroughly satisfactory in every respect the Keuffel & Esser Co., 127 Fulton street, New York, offer a variety. They are all equally efficient and differ only in degree of finish and fineness of graduation. The cheaper instruments are of high quality and are highly recommended to engineers who do not feel that they can pay a high price for an elaborately finished one.

Non-Magnetic Watches.—A non-magnetic watch is a timepiece that nearly every man who has anything to do with marine machinery will appreciate, particularly because of the very general use of electricity. In order to supply the demand for these and yet furnish a first-class timekeeper a company has applied the non-magnetic qualities to the celebrated "Paillard," one of the most famous Swiss movements, and is now offering them to the American market. Much information regarding these watches can be had in catalogues and circulars from L. R. Trickel, 18 John street, New York.

Holly Gravity Return System.—A device recently applied to steam vessels and now in use on steamers of the Hartford Line, the Clyde and other lines, is the Holly Gravity Return System. This device has no working parts and carries back to the boilers all condensation occurring in the steam pipes and elsewhere, and is designed to dispense with traps, pumps, etc. It works where there is any steam pressure and takes a very small amount of steam to keep it in motion. The rolling or pitching of a vessel does not check its working. Circulars and other information regarding this device are issued by the Holly Steam Engineering Co., Hartford, Conn.

An Increased Demand for Marine Paint.—The success met by Edward A. Bunker in introducing the Japan paints, advertised elsewhere in Marine Engineering, has necessitated his removal to larger and better quarters at 20 Broad street, New York. With his increased facilities he is now prepared to answer even more promptly than ever before all inquiries and give any other information desired. A new kind of paint which Mr. Bunker is putting on the market is called "Veluwe." This is a paint varnish of fine quality, unusual in its elasticity and brilliancy. It is particularly adapted to interior and exterior decorations on metal and wood work. Circulars have been issued regarding this paint.

Electrical Devices for use on Ship Board.—The Electro-Dynamic Co., 224 Chestnut street, Philadelphia, has devoted special attention to developing electrical devices for marine uses outside of the mere installation of marine lighting plants. One of these devices is a helm angle indicator. These are in use on several of the transatlantic liners, and have proved very efficient. Another device is an engine speed and direction indicator. This indicator is in use on board a dozen of the best known transatlantic liners and coasting vessels, also on several steam yachts and in the navy. Circulars regarding these devices can be had upon application to the company.

ALFRED B. SANDS & SON,

YACHT AND MARINE PLUMBERS,

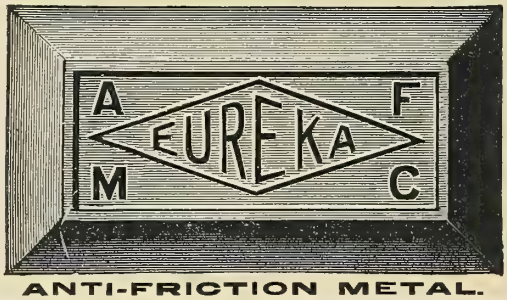
And Manufacturers of

PUMP WATER CLOSETS

For above or below Water Line. Suitable for Naval Vessels, Yachts, Torpedo Boats and Launches,

PUMPS, TANKS, Etc., Etc.

134 BEEKMAN ST., - - NEW YORK.



ANTI-FRICTION METAL.

Especially adapted for HEAVY AND HIGH SPEED ENGINE BEARINGS AND ALL KINDS OF MARINE WORK.
Outwears, runs cooler and with less lubrication than any babbitt or anti-friction metal made.
Descriptive Circular, Testimonials and Samples Free.
All Kinds of Superior Brass, Bronze, Copper and Non-corrosive White Metal Castings.

FENTON & CO., SELLING AGENTS,
39 Cortlandt St., New York.

LAMPS

For Every Purpose.

We make lamps for Yachts, Boats, Boathouses, Cabins, Wharves, Walks, or anywhere, indoors or out, where a good strong light is wanted.

Our goods need no recommendation from us. They are the standard. Other lamps are said to be "equal to," "like," or "as good as"

THE NEW ROCHESTER.

To be sure the lamps offered you possess the merits peculiar to the genuine, insist on seeing the name stamped in the metal. Catalogue free. We give as much attention to making special lamps, repairs, etc., as to our regular line.

THE ROCHESTER LAMP CO.

42 Park Place and 37 Barclay St., New York.

NEW PRICE LIST FOR PACKING.—A price list has just been published by the U. S. Metallic Packing Co., 427 North Thirteenth street, Philadelphia, Pa., of its various types of metallic packing. This list is one that every man connected with engines should have on file, because of the specific information contained therein.

SUCCESSFUL STEAM DEVICES.—The late Jacob G. Neafie, of the Neafie & Levy Ship Building Co., wrote to H. Bloomsburg & Co. regarding their steam "jets" as follows: "We have used many of them, and in all cases they have given entire satisfaction * * * In one instance we were requested to take out a boiler which failed to make the steam required, owing to its crowded condition. We used your jet and the parties were satisfied with the results." Regarding the Bloomsburg circulator, the engineer of the steamer Chester, of the Wilmington Steamboat Co., says: "Your circulator has given perfect satisfaction, even beyond our expectations. Our steaming capacity has increased wonderfully since their introduction. Before we put them in I could not hold steam, with feed water thrown overboard, long enough to take a set of indicator cards, but now I can hold all of the steam that the engine can use with throttle wide open, for hours at a time."

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

A KLONDYKE MINE RIGHT HERE.

It is in the new patent Paragon Marine Boiler, illustrated and advertised elsewhere. Half interest or State rights for sale.
Address CAPT. M. DE PUY, 19 South St., New York.

MANAGER WANTED.

Wanted, a manager competent to design, direct and superintend the construction of boats and yachts. Should have a knowledge of steam and gasoline engines, and commercial experience is desirable. Address, stating experience and salary required, MANAGER, care MARINE ENGINEERING, World Building, New York.

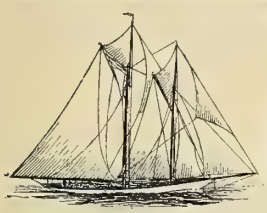
OPEN FOR ENGAGEMENT.

Naval engineer, graduate of United States Naval Academy, engineering course. Seven years' excellent practical experience. Excellent references. Speaks French and Spanish, some Danish.
Address S., MARINE ENGINEERING.

PROFESSIONAL CARD.

H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.
Manufacturer of **Screw Propellers** for Usual and for Special Work.
The Allen Dense Air Ice Machine for Steam Vessels.
41 MAIDEN LANE, NEW YORK.



WHEN CALKING
DECK SEAMS AND CHECKS IN RAILS, MASTS AND BOOMS,
USE ELASTIC SEAM COMPOSITION.
It is made in all colors and is positively guaranteed superior to any other seam preparation. It will not crack. When the wood expands it shrinks, and when the wood shrinks it expands. In use on steam yachts SOVEREIGN, CORONET, ALMY, RESTLESS, VENTURE, and many other yachts INTREPID, VALIANT, ELANOR, CLERMONT, BLACK PEARL, and other vessels.
COLE & KUHLS, Foot of 24th St., BROOKLYN, N. Y.

MARINE ENGINEERS, ATTENTION!
THE AMERICAN SCHOOL OF CORRESPONDENCE
(Chartered by the Commonwealth of Massachusetts.)
Offers a SPECIAL COURSE in MARINE ENGINEERING.

This course has been planned by the foremost marine experts of this country, and is thoroughly practical and scientific.

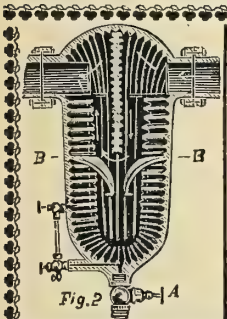
We are SPECIALISTS, and teach ONLY
Engineering { STEAM / ELECTRICAL / MECHANICAL } { *STATIONARY* / *MARINE* / *LOCOMOTIVE* }

We do not **attempt** to teach anything and everything, but **do** teach the above courses thoroughly and well.
Our corps of trained instructors is selected from the best scientific schools of the country, and they devote their entire time to the students in the above important branches of mechanical science.
Thousands of enthusiastic students endorse and commend the progressive methods of our system of instruction.

SPECIAL OFFER TO READERS OF MARINE ENGINEERING.

33 1-3% DISCOUNT. For the next **30** days we will give readers of MARINE ENGINEERING a reduction of 33 1-3 per cent from our regular scholarship price (easy terms if desired). FOR 30 DAYS.
Your name on a postal card will bring you a handbook of the school, containing complete schedules of courses, pages from instruction papers, etc., etc.

YOU CANNOT AFFORD TO MISS THIS OPPORTUNITY.
AMERICAN SCHOOL OF CORRESPONDENCE, 156 Tremont St., BOSTON, MASS.



HINE ELIMINATOR separates WATER from live steam and extracts OIL from exhaust.

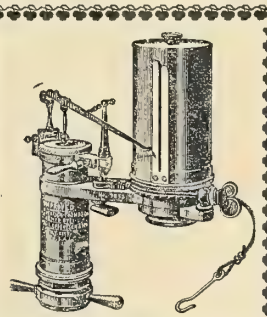
SHE IS A BEAUTY.

Her original is on full size pack of playing cards we are sending out for 2 labels (showing weights) cut from front of EUREKA PACKING boxes. All cards are special in 3 colors.

TRY EUREKA.

DO YOU PAY

Same attention to the ECONOMICAL running of YOUR engine as stationary plants? Most of them own INDICATORS and keep their valves in proper shape. It will pay YOU to send for circular. We are making special prices to introduce them on S. S. and yachts.



JAS. L. ROBERTSON & SONS, 218 FULTON ST., N. Y.

RAINBOW PACKING

Makes a Steam Joint Instantly.

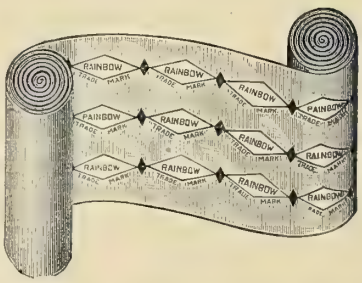
HONEST JOHN.

MR. JOHN H. DEMING.
General Superintendent Peerless Rubber Manufacturing Co.

THE COLOR OF RAINBOW IS RED.

NOT AFFECTED BY OILS, AMMONIA LIQUORS, STEAM HEAT OR ALKALIES.

None genuine without the Trade-Mark.



RAINBOW PACKING HAS 3 ROWS OF DIAMONDS IN BLACK EXTENDING THROUGHOUT THE ENTIRE LENGTH OF EACH AND EVERY ROLL.

Fac-simile of a Roll of Rainbow Packing.

Who invented and who is the only man in the world who can make or ever has made

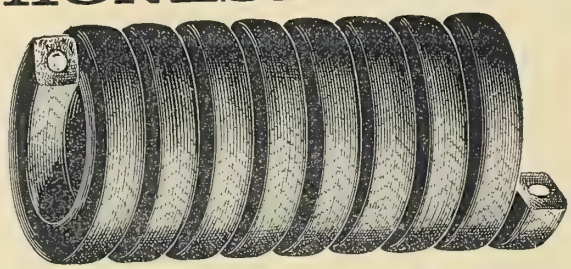
Rainbow Packing.

RAINBOW GASKETS are especially adapted for Low Pressure Steam and Hot Water Heating Apparatus.

PEERLESS DISCS for Russell, Frink, Walworth, Jenkins, Lorain and Kelly & Jones Valves.

"HONEST JOHN."

Made in both Straight and Spiral Form.



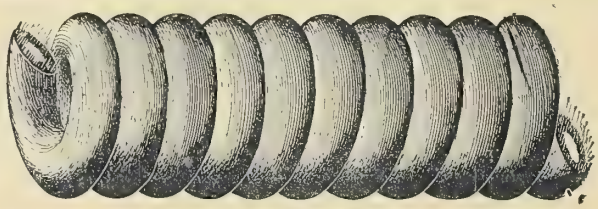
Once Tried, Always Used.

Put up in Boxes.

HYDRAULIC RAINBOW CORE PACKING.
The Best Hydraulic and Cold Water Packing in the World.

Hercules Combination.

Always Tight. Leaves the Stem Clean.



Will Hold 400 lbs. Steam.

Metallic Stop Valve Packing.

SEND FOR CATALOGUE.

Patented, Copyrighted and Manufactured Exclusively by

THE PEERLESS RUBBER MANUFACTURING CO.,

16 Warren Street, New York.

16-24 Woodward Ave., Detroit, Mich.
202-210 So. Water St., Chicago, Ill.
17-19 Beale St., and 18-24 Main St., San Francisco, California.

DANIEL'S PATENT P. P. P. DIAGONAL

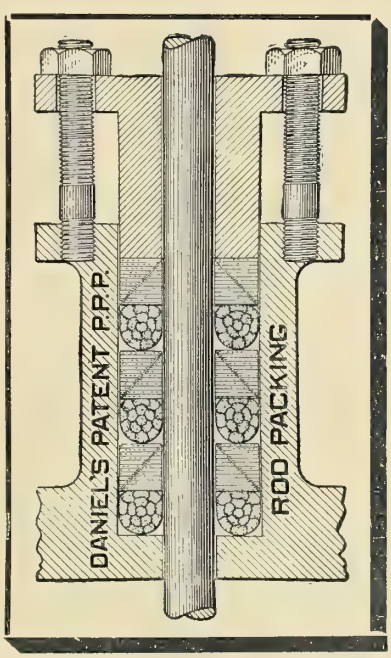
Rod Packing

For all Purposes. Steam, Water, Oil, Ammonia, Air, Etc.

BRANCH OFFICES.
PITTSBURG, 105 Water Street.
SAN FRANCISCO, 514 Mission Street.

BRANCH OFFICES.
CHICAGO, 4 S. Canal Street.
TOLEDO, 638 Leonard Street.

Wedges which under slight pressure slide on each other, compensating for the wear made by the rod, and adjusts itself to all irregularities of rod and box. An absorbent oil cushion, insuring perfect lubrication.



The Most Elastic Packing,
The Cheapest Packing,
Less Friction on the Rod than any other.
Wears the longest and gives the least trouble and the greatest satisfaction.

BEWARE OF INFRINGERS AND IMITATORS.

SEND FOR BOOKLET.

REGISTERED.

PISTON PACKING
TRADE MARK
PERFECT
WARRANTED
P.P.P.
DIAGONAL
PAT. AUG. 7, 1894

Have you seen Daniel's Patent Packing Gauge for Measuring and Cutting accurately Rod Packing, and **given away?**

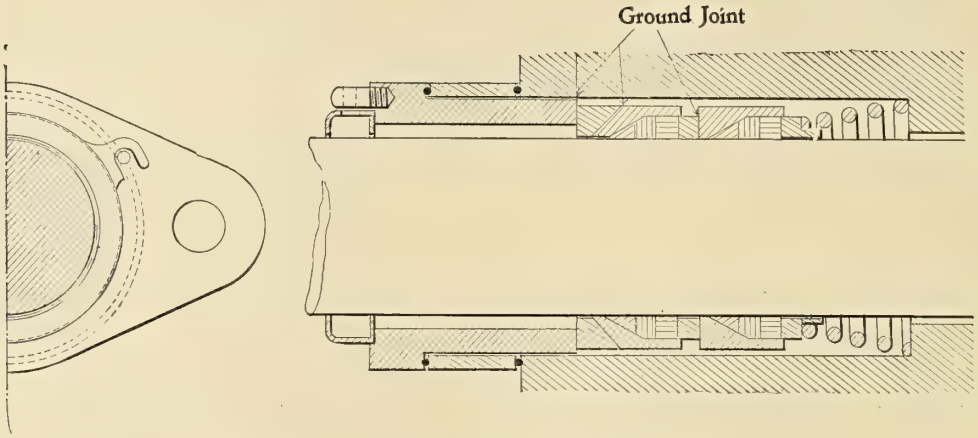
Manufactured ONLY by

C. A. DANIEL,

409 MARKET STREET, PHILADELPHIA, PA.

We have 90,000 packings in use. We think this fact speaks for the quality of our goods.

It is the CHEAPEST as well as THE BEST PACKING.



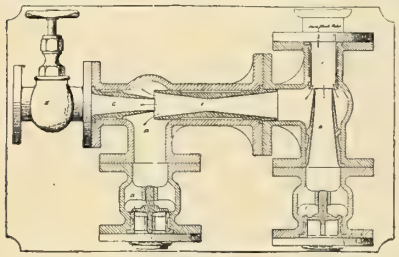
THE UNITED STATES METALLIC PACKING COMPANY,

427 North Thirteenth Street, PHILADELPHIA.

Craig's Steam, Vacuum and Hydraulic Specialties,

Consisting of PATENT

IMPROVED SAFETY QUICK-ACTION AUTOMATIC STOP VALVES,



Feed Water Circulator.

For Pipes of all kinds under Pressure, for Steam, Water or any other fluid.

IMPROVED AUTOMATIC EXHAUST RELIEF VALVES,

For Condensing and Non-condensing Engines, Marine or Stationary.

HEATING and CIRCULATING APPARATUS for STEAM BOILERS.

ADDRESS

WILLIAM CRAIG, 42 Cortlandt St., New York.

KATZENSTEIN'S

METALLIC PACKINGS

Of different designs for stuffing boxes of engines, pumps, etc.

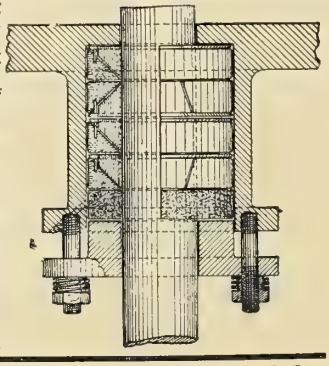
Flexible Tubular Metallic Packing for Slip Joints on Steam Pipes.

Metallic Gaskets for all kinds of Flanges.

Highest Grade Anti-Friction Meta' for Bearings.

Patent Automatic Life Boat Detacher.

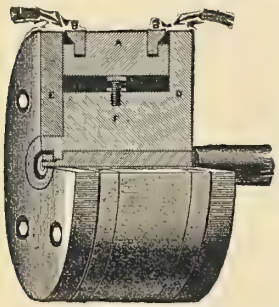
Patent Duplex Water Tight Compartment Doors.



L. KATZENSTEIN & CO.,

General Machinists' and Engineers' Supplies, : :

357 WEST ST., NEW YORK, U. S. A.



SELF-ADJUSTING STEAM CYLINDER PACKING

for **STEAMSHIP, YACHT, TUGBOAT,** and all classes of **ENGINES,** high and low pressure.

Makes piston perfectly tight with minimum of friction. Increases revolutions of wheel, saves fuel, secures true cylinder. Owing to its immediate action, engines can be started, stopped, or reversed instantly. Used in the engines of the leading Steam Yachts and Vessels.

We guarantee no leakage of Steam over piston.

Manufactured and licenses granted to manufacture under our patents by

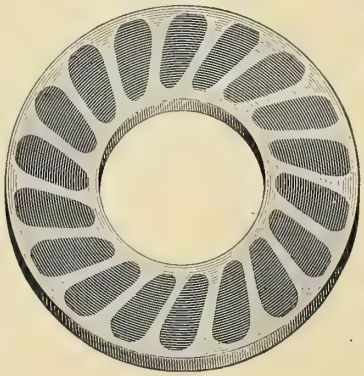
THE ST. JOHN CYLINDER PACKING CO.

General Offices: 108 Fulton Street, N. Y. City, N. Y.

SHELDON H. BASSETT, Gen'l Agt.

THE GRAPHITE LUBRICATING CO.,

BOUND BROOK, N. J., U. S. A.,



MANUFACTURERS OF PATENT

Graphite and Bronze

BUSHINGS, BEARINCS AND **WASHERS.**

For all kinds of

Machinery, Hoisting Apparatus, Tackle Blocks,

Etc., Etc.

Can be used with without Oil.

Marine Engine For Sale.

One second hand Triple Expansion Marine Engine, 4½ x 7½ x 12 inches, 8 inch stroke, equal to new, will be sold cheap.

FRANK TOOMEY, 131 North Third St., Philadelphia.

No Rubber on the Rod. A Cushion in the Right Place.

KNOWLTON PACKING CO.,
19 Pearl St., BOSTON, MASS.

THOS. C. WARLEY & CO.,

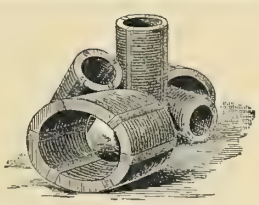
Manufacturers of

BOILER CLEANSING COMPOUNDS

Main Office: No. Eleven So. Ninth St., Philadelphia, Pa.
P. O. BOX 1262.

These Compounds are unequalled. They give satisfaction where others fail. They are especially adapted for use in Marine Steam Plants. WRITE FOR DESCRIPTIVE CIRCULAR.

GASKETS.



ANY SIZE OR SHAPE, FOR THE SMALLEST HAND HOLE OR THE LARGEST CYLINDER TOP. : : : :

Our various grades of stock are adapted for any and all kinds of joints, and will give entire satisfaction under the highest pressures and most severe conditions.

BOSTON BELTING CO.

JAMES BENNETT FORSYTH,
Mfg. Agt. and Gen. Mgr.,
Manufacturers of
BELTING, HOSE, PACKING, VALVES AND RUBBER GOODS
of the Best Quality.

BOSTON: 256-260 Devonshire St.
NEW YORK: 100 Reade St.
BUFFALO: 90 Pearl St.
CHICAGO: 109 Madison St.
SAN FRANCISCO: 24 Fremont St.
NEW ORLEANS: 316-318 St. Charles St.

RANDOLPH BRANDT,

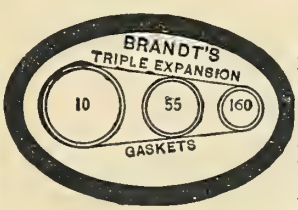
38 Cortlandt Street, New York.

SPECIALTIES.

SELDEN'S PATENT PACKINGS

are made either with a rubber core or a canvas core and will keep stuffing boxes tight with less friction than any other packing.

BRANDT'S TRIPLE EXPANSION GASKETS



are the best man-hole and hand-hole gaskets for high pressures.

BRANDT'S PUMP VALVES will stand hot water and oils.

The best grades of **Rubber Hose, Joint Packings** and other **Engineers' Stores.**

Orders filled promptly and satisfaction guaranteed. Your trade is solicited.

THERE IS NO SATISFACTORY SUBSTITUTE FOR....

GARLOCK'S HIGH-GRADE PACKINGS.

THEY ARE THE IDEAL PACKINGS FOR STEAM, WATER, GAS, AMMONIA, ETC.

THE STANDARD FOR 18 YEARS,

AND HOLD THE RECORD FOR QUALITY, DURABILITY AND ECONOMY.

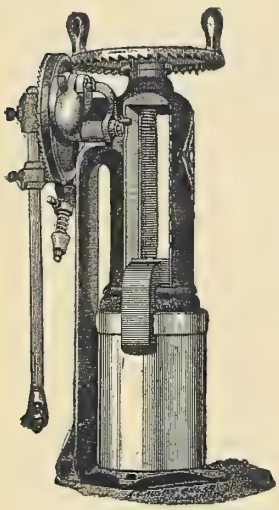
THE GARLOCK PACKING CO.

NEW YORK. BOSTON. CHICAGO. PHILADELPHIA. PITTSBURG. CLEVELAND. ST. LOUIS. DENVER.

MAIN OFFICES AND FACTORIES: **PALMYRA, N. Y.; ROME, GA.**

SEND FOR SAMPLES, NEW CATALOGUE AND PRICES.

National Automatic Lubricator, Patented.

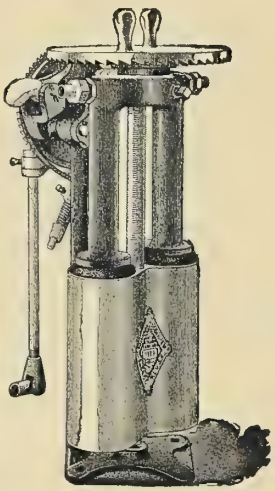


AN ABSOLUTE FORCED FEED.

Positive, Reliable,
Economical, Satisfactory.

Guaranteed to save 30 to 60 per cent of oil and give better results to frictional parts. Not affected by change of temperature or consistency of oil.

If you are thinking of getting a New Engine or Pump, specify this Lubricator. It will be money in your pocket.



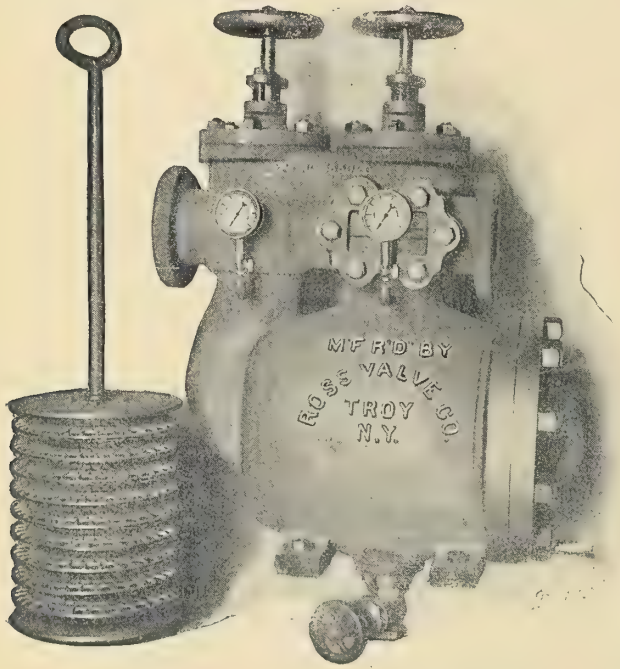
WRITE FOR CATALOGUE OF LUBRICATORS AND SIGHT FEED ATTACHMENTS.

National Lubricator Co.,

BUFFALO,
SHERWOOD MFG. CO.

ALBANY, N. Y.

THE ROSS FEED WATER FILTER.



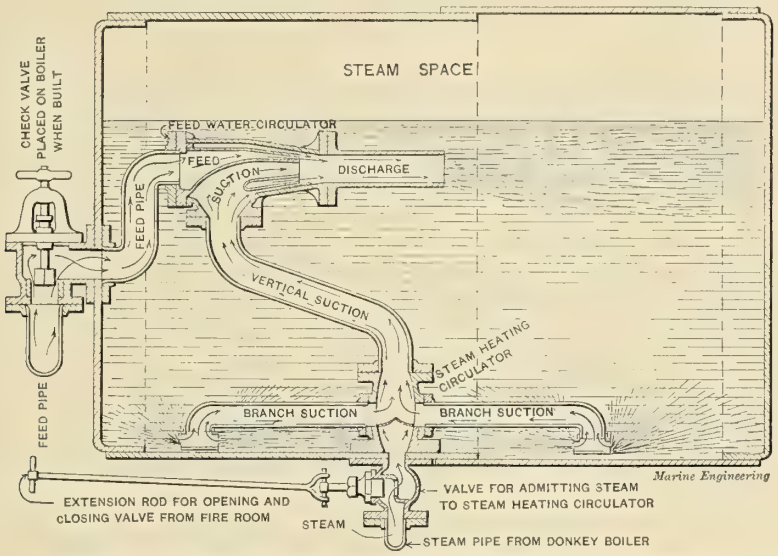
In use on the Steamships Majestic, Doric, Ionic, Belgic, Gaelic, Civic and Bovic of the White Star Line; Kaiser and Salla of the North German Lloyds; Armenian, Victorin and Cestrian of the Leyland line; the Kaiser Wilhelm der Grosse of the Hamburg-American line, and many other vessels.

For full particulars, address

THE ROSS VALVE CO., - TROY, N. Y.

THE EQUILIBRIUM CIRCULATOR.

For heating and circulating the water in steam boilers; increases the steaming capacity from 5 to 15 per cent., thus saving in coal consumption. Equalizes expansion, thereby preventing leaks due to unequal strains, thus saving cost of repairs. By causing a rapid movement of the water over the heating surfaces, the steam bubbles are carried to the surface as soon as formed, thus preventing the disturbance which often causes Foaming or Priming. This Apparatus has been used with great success to stop Foaming, and has been very successful in stopping Pitting, which often causes the total destruction of a boiler in a few years.

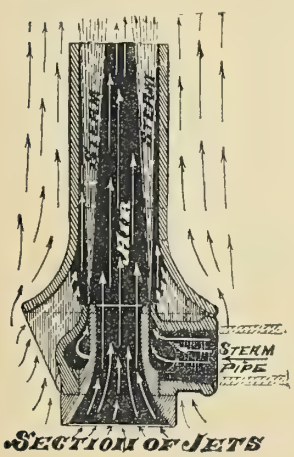


SECTION VIEW OF CIRCULATING APPARATUS ON LARGER SCALE THAN BOILER

Circulators are used in steamships of the American Line, Merchants & Miners' Line, Norwich Line, New Haven Line, and many of the most modern yachts, merchant vessels, ferry boats and excursion boats.

The Improved Annular Steam Jet.

The most powerful and economical Jet on the market, costing but little more than a plain ring jet, giving a draft equal to a fan, and a suction varying from $\frac{1}{2}$" to $1\frac{1}{2}$" of water. Has given a third more power than the famous Nickols Jet with less steam consumption.

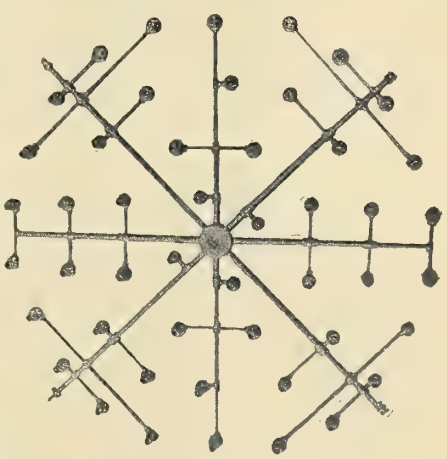


SECTION OF JETS

Jets are used on steamers of the following lines:

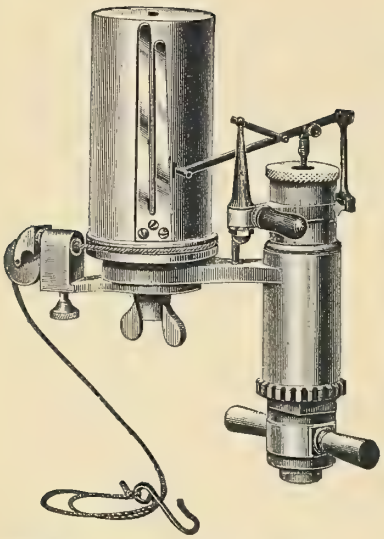
Wilmington Steamboat Co.,
Norwich Line,
Merchants & Miners' Line,
Long Island Railroad Co.,
Old Dominion S.S. Co.,
The Hartford Line,
The Plant Line,
and in many steam vessels in all parts of the country.

For further particulars send to the manufacturers,



PLAN OF JET.

H. BLOOMSBURG & CO., NEWPORT NEWS, VA.



AMERICAN THOMPSON IMPROVED INDICATOR.

Original Thompson Indicator.

IDEAL REDUCING WHEEL, PANTOGRAPH AND PLANIMETER.

MARINE { STEAM GAUGES, ENGINE INDICATORS, POP SAFETY VALVES, CLOCKS, COUNTERS, &c. } —A— SPECIALTY.

AMERICAN STEAM GAUGE CO.,

CHICAGO. NEW YORK.

34-36-38 Chardon Street, BOSTON, MASS.

SEND FOR CATALOGUE F.

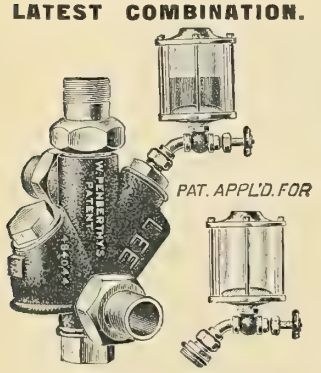
The Lee

W. PENBERTHY PATENT.

BALL VALVE AUTOMATIC

INJECTOR.

LATEST COMBINATION.

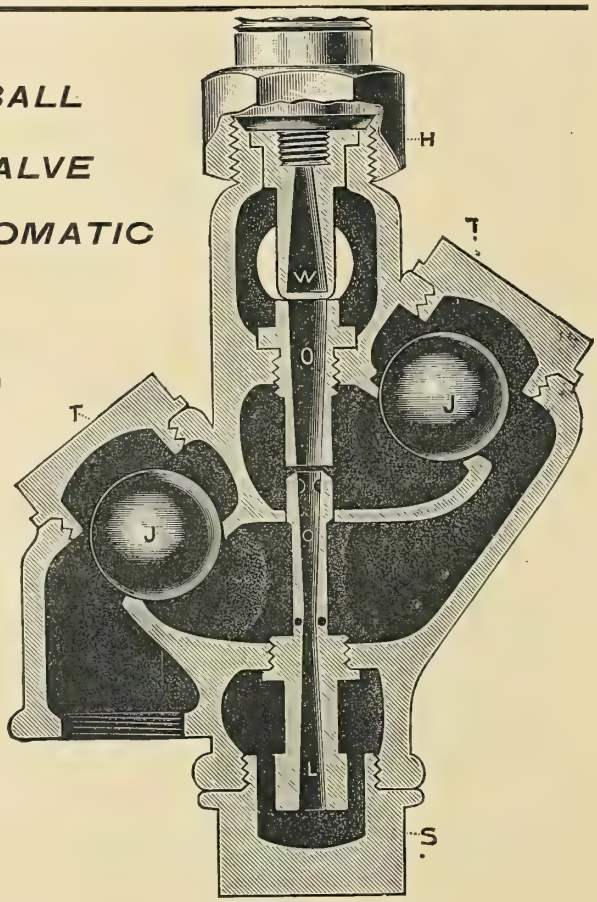


PAT. APPL'D. FOR

T. J. S. Purger Attachment.

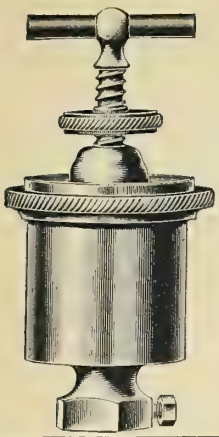
THE BEST GOODS ON THE MARKET.

SEND FOR ILLUSTRATED CATALOGUE.



LEE-PENBERTHY MFG. CO.,

Nos. 101-103 Abbott Street, - DETROIT, MICH.



THE

Standard Improved

AUTOMATIC GREASE CUP.

PHILLIPS' PAT. OIL CUPS,

Lubricators, Etc.

Manufactured only by

W. P. Phillips & Co.,

71 Sudbury St., Boston, Mass.

BUFFALO

FEED WATER HEATER

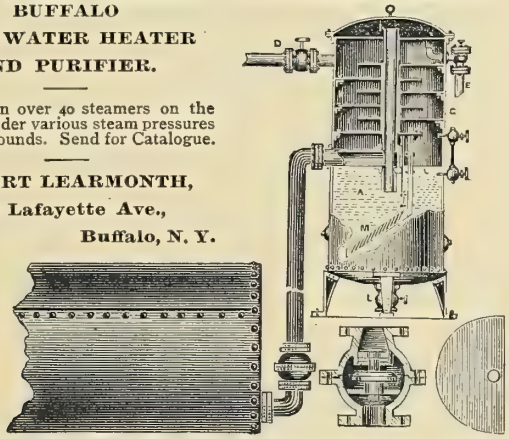
AND PURIFIER.

In use on over 40 steamers on the lakes. Under various steam pressures up to 250 pounds. Send for Catalogue.

ROBERT LEARMONTH,

200 Lafayette Ave.,

Buffalo, N. Y.



To Steamship Builders, Owners and Engineers:

The Holly Gravity Return System

Is the only Automatic and perfectly reliable method of returning all the high pressure condensation and entrainment from Main Pipes, Separators, Jacket Cylinders, to Boilers, without loss of temperature; saving Fuel, Repairs, Packing, &c.

No attention required, as there are **no working parts.**

They work in **heaviest seas** as well as on land, constantly taking the water from the Receivers back to Boilers from the time steam reaches a few pounds pressure till it goes down at the end of the voyage.

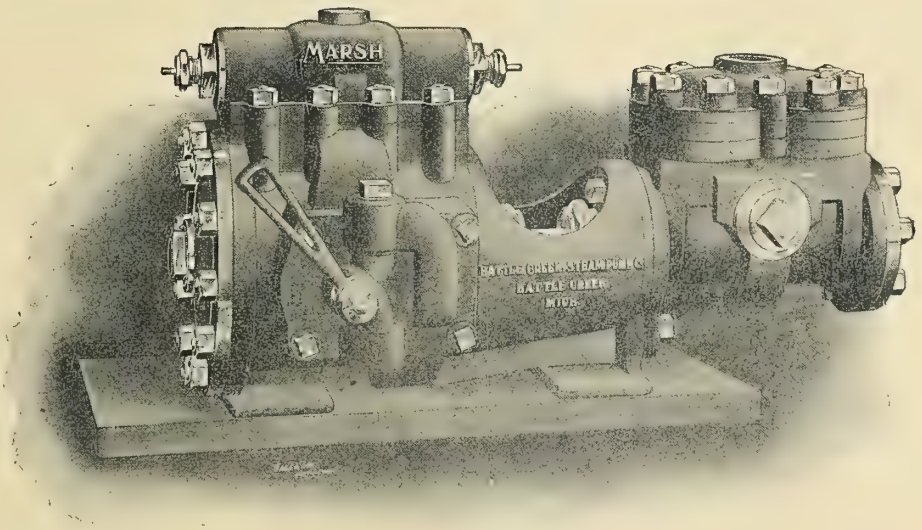
HOLLY STEAM ENGINEERING CO.,

28 HIGH STREET,

HARTFORD, CONN.

BATTLE CREEK STEAM PUMP CO.,

Marsh Yacht Pump.



Catalogue or other information will be sent on application.

NOTE: Two Marsh Yacht Pumps on the "Ellide," the fastest yacht in the world.

More than 7 Steamship Lines equipped with Refrigerating Machinery.

KILBOURN

935 Drexel Bldg., Philadelphia.

Our Machine for YACHTS requires 5 ft. square only.

BINDERS for MARINE ENGINEERING Handsomely Bound in Cloth, **BY MAIL, 75c.**

The Mabbs Hydraulic Packing.

USED ON FASTEST ATLANTIC LINERS.

This packing has no equal for Propellers, Stern Pipes, Water Works, Deep Mine Pumps, Ice Machines and all machinery using cold water.

It is the most pliable and durable Hydraulic Packing in the market. *It can be worn entirely out, simply by adding new packing when required, and not disturbing the old.* It will never cut a rod or cylinder, on account of the nature of the material, it being always a good lubricant in itself.

MABBS HYDRAULIC PACKING COMPANY,
BOX 829, CHICAGO.
Telegraphic Address: Mabbs, Board of Trade Bldg.

AIR-MOVING MACHINERY.

FOR

VENTILATION AND FORCED DRAFT.

Bulkhead Fans for any service where not more than FOUR INCHES water column pressure is required. Placed in a bulkhead a SEYMOUR FAN takes up very little room and is most efficient.

BELT-DRIVEN FANS.
DIRECT CONNECTED ELECTRIC FANS.
DIRECT-CONNECTED STEAM FANS.
DIRECT-CONNECTED WATER MOTOR FANS.
360 PATTERNS OF SPECIAL FANS.

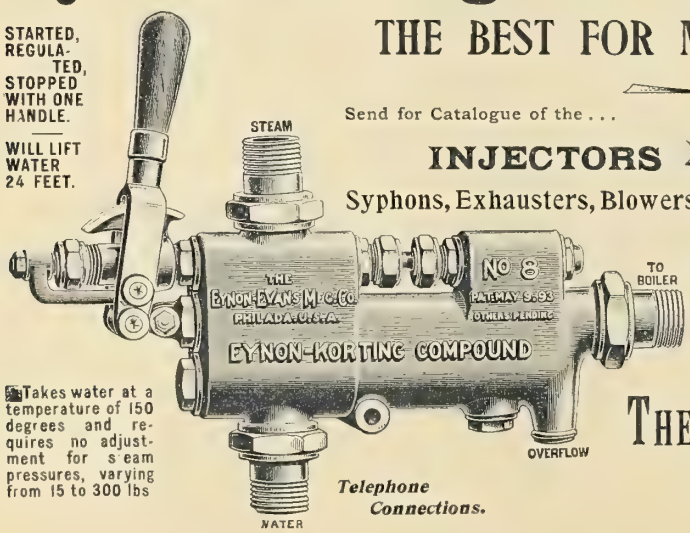
Send for Catalogue.

J. M. SEYMOUR, Jr.,
No. 43 Lawrence Street, Newark, N. J.

Eynon-Korting Compound Injector.

STARTED, REGULATED, STOPPED WITH ONE HANDLE.

WILL LIFT WATER 24 FEET.



Takes water at a temperature of 150 degrees and requires no adjustment for steam pressures, varying from 15 to 300 lbs

Telephone Connections.

THE BEST FOR MARINE, LOCOMOTIVE AND STATIONARY BOILERS.

Send for Catalogue of the . . .

INJECTORS **CONDENSERS**

Syphons, Exhausters, Blowers, Ventilators, Blast Nozzles, Bilge-Pumps, Etc.

BRONZE FOUNDRY DEPARTMENT:

Copper Castings, Phosphor and Manganese Bronze, Red and Yellow Brass Castings.
Capacity 10,000 lbs. per heat.

THE EYNON-EVANS MFG. CO.,
1513 Clearfield Street,
Philadelphia, Pa.

MARVELLOUS RESULTS

ARE OBTAINED FROM THE

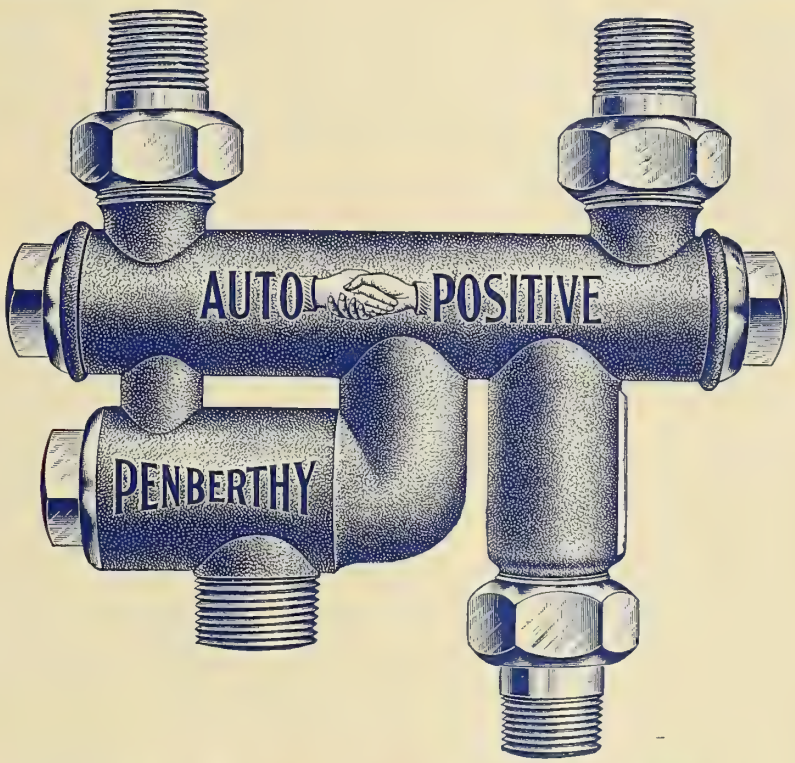
AUTO-POSITIVE

Automatic. Positive.

TRADE PENBERTHY MARK.

Automatic. Positive.

New Design. *New Principles.*



The 20th Century Wonder. *Only Six Working Parts.*

HIGH PRESSURE and HOT WATER **MARINE INJECTOR.**

WORKING RANGE

12 to 15 lbs. low to 230 to 235 lbs. high steam, or
30 " 35 " " " 275 " 290 " " "

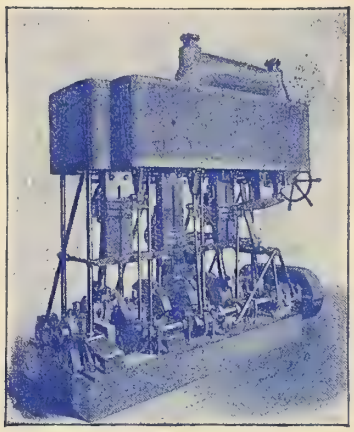
HANDLES HOT WATER

143 to 145 degrees and under with 75 to 100 lbs. steam.
133 " 135 " " " " 50 " 120 " "
118 " 120 " " " " 25 " 150 " "
98 " 100 " " " " 18 " 175 " "

60 DAYS' TRIAL TO ANY STEAM VESSEL.

SEND FOR CIRCULARS.

PENBERTHY INJECTOR CO. 115 SEVENTH ST., **DETROIT, MICH.**



MARINE ENGINES

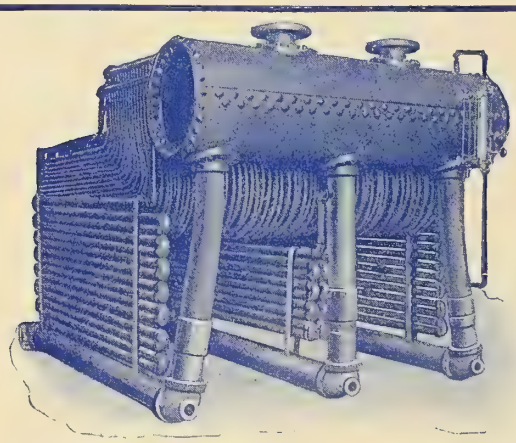
Quadruple and Triple Expansion, Compound and Simple. 15 to 3,000 Horse Power.

"Seabury's" Water Tube Boilers.
Steam and Sail Yachts.

The Only Naphtha Launch.

Send 10c. stamp for Catalogue.

GAS ENGINE & POWER CO.,
AND
CHARLES L. SEABURY & CO.,
CONSOLIDATED,
Morris Heights, New York City.

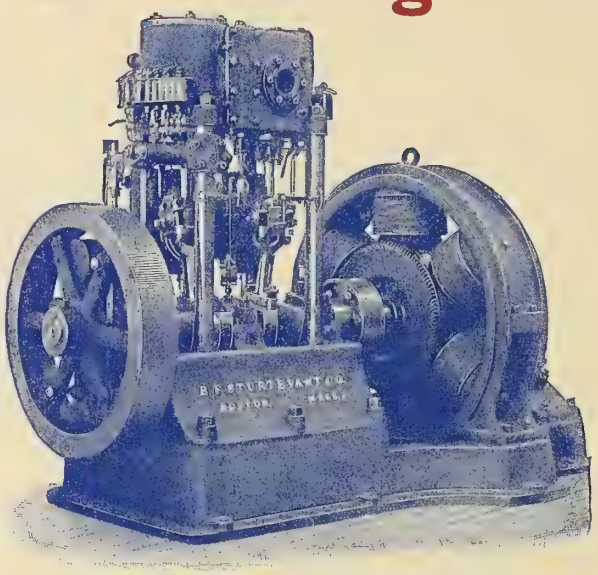


Perspective view of the 250 H. P. boiler built for steamboat "Clara," having 6 feet face and 8 feet length; 37 7-12 square feet of grate area and 1900 square feet heating surface. Weight of boiler and water, 14,000 lbs.

We claim for the Boyer Sectional Water Tube Boilers, that they are of an entire new design, are simplest in construction, are accessible to all parts, are rapid steamers with short circulation, have low centre of gravity, have no joints in the fire, have no dead ends, occupy less space in width, length and height than any other, are easily fired, can be repaired or set up by any ordinary mechanic, do not require a brick casing and are shipped whole or knocked down into packages for transportation by man or beast.

BOYER PATENT SECTIONAL WATER TUBE BOILER CO.,
90 Wall Street, New York, N. Y.

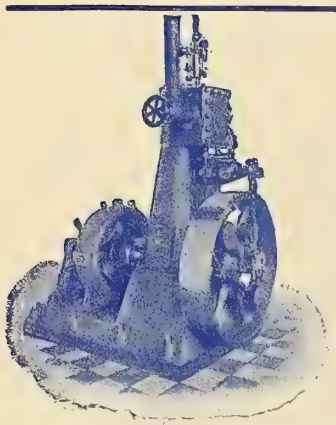
STURTEVANT Generating Sets



SIZES UP TO 65 K. W.
Send for Catalogue.

B. F. STURTEVANT CO.
Works: Boston, Mass., U. S. A.

BOSTON. NEW YORK. CHICAGO. PHILADELPHIA. LONDON.
GLASGOW. BERLIN. STOCKHOLM.



"Shepherd" ENGINES.

MARINE, for Yachts, Tugs, Steamers and Ferries.

STATIONARY AUTOMATIC, for lighting and power.

DAVIS-FARRAR CO., Erie, Pa.

LUNDELL DIRECT-CONNECTED GENERATING SETS.

These equipments are so designed that a minimum of weight and space occupied are obtained with no loss of power or efficiency as a consequence. They have no equal for steam yachts or steamships of any kind, and they are adapted for use in connection with any make of engine.

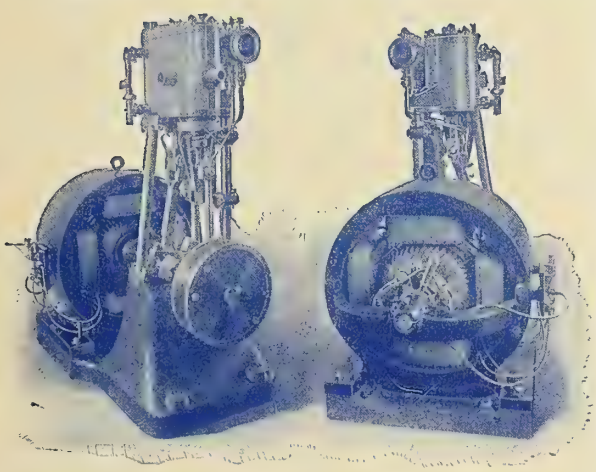
A FEW USERS:

J. Pierpont Morgan, ... Yacht "Corsair."
A. J. Drexel, ... Yacht "Marguerita."
Merchants' & Miners' Transportation Company.
M. C. D. Borden, ... Yacht "Vidette."
Tugboat "Daniel S. Lamont." Starin's Line.

CORRESPONDENCE INVITED.

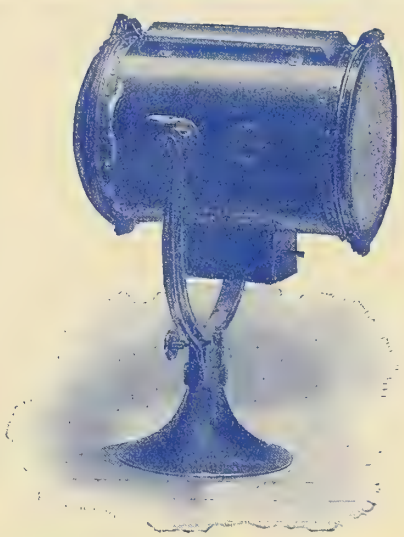
SPRAGUE ELECTRIC COMPANY,
Twenty Broad Street, New York City.

THE...
BULLOCK
Electric Mfg. Co.



Generator and Engine in W. R. Hearst's Yacht "Buccaneer."

CINCINNATI, O.



MANHATTAN ELECTRIC PROJECTORS.

ANY METHOD OF CONTROL. ANY CANDLE POWER.
Adopted by Principal S. S. Lines and Yachts.

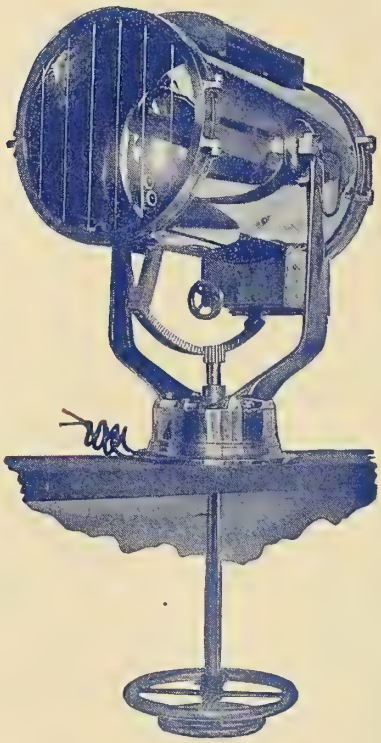
Manhattan General Construction Co.,
11 BROADWAY, NEW YORK.

Electric Searchlight Projectors.

ANY CANDLE POWER.

ADAPTED TO LAKE AND SEA-GOING VESSELS

Special small projectors for yachts.



Send for Catalogue "A"

THE

CARLISLE & FINCH CO.,

834 West Sixth Street,

Cincinnati, Ohio.

Anything from

A 16-FOOT TENDER TO A 100-FOOT YACHT

Fitted with

The Simplest, Safest, Speediest and Most Reliable of Motors,

THE DAIMLER.

Made in Sizes from 1 to 25 Horse Power.

Everything in the line of Boats.

DAIMLER MOTOR WORKS,

937-945 Steinway Ave., Steinway, Long Island City, N. Y.

M. W. FOGG

Manufacturer of

Cushions
Draperies
and
Bedding

For

YACHTS
STEAMSHIPS
ETC.

195 Front St. Cor. Fulton St.

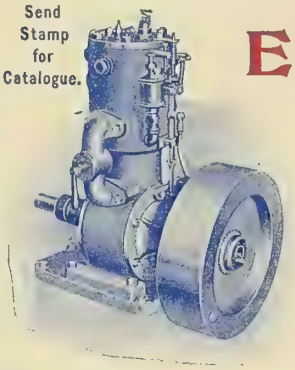
New York City.

GAS AND GASOLINE

ENGINES.

Both Stationary and Marine.

Send Stamp for Catalogue.



ENGINE CASTINGS....

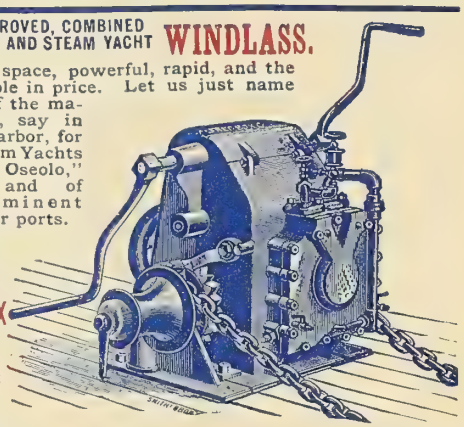
Dynamo and Motor Parts and Complete Machines. Electrical Supplies. Telephones.

MIANUS ELECTRIC CO., BOX A, Mianus, Conn.

BOX'S IMPROVED, COMBINED HAND AND STEAM YACHT WINDLASS.

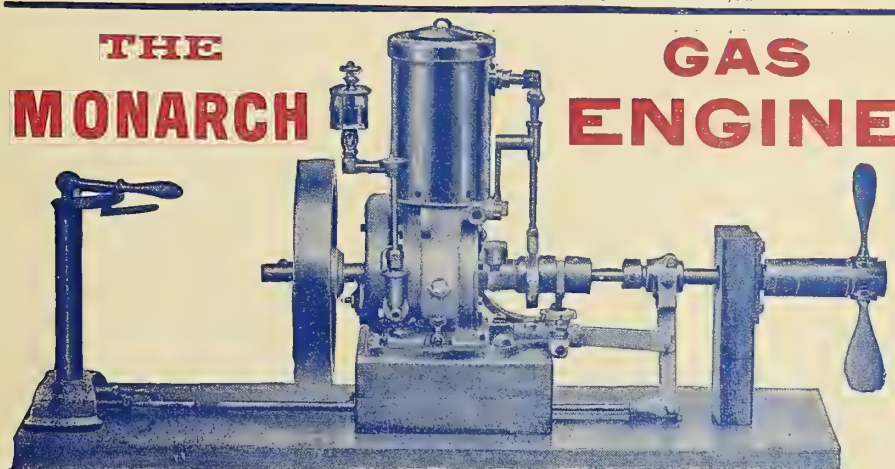
Minimum space, powerful, rapid, and the most reasonable in price. Let us just name one or two of the machines in use, say in New York Harbor, for instance—Steam Yachts "Neaira," "Oseolo," "Vergana," and of course, prominent yachts in other ports.

Particulars Cheerfully Furnished.



ALFRED BOX & CO.,
Front, Poplar & Canal Sts.,
PHILADELPHIA, PA.

THE MONARCH GAS ENGINE



The Best ENGINE in the Market.

LAUNCH AND ENGINE FROM $250 UP.

Send for Circular.

G. R. GASOLINE ENGINE & YACHT CO.,
99 Front St.,
GRAND RAPIDS, MICH.

GAS ENGINES AND LAUNCHES.

WOLVERINE MOTOR WORKS, GRAND RAPIDS, MICH.

DON'T MOVE!!!

Until you have our prices on **YACHT, BOAT** and **CANOE** fittings and supplies. Send specifications for low figures to L. W. Ferdinand & Co., 184 Federal St., foot of Summer St., Boston, Mass.

TREGURTHA WATER TUBE **BOILERS,** STEAM AND GASOLINE **LAUNCHES AND ENGINES.**

Send Five 2c. Stamps for Catalogue.

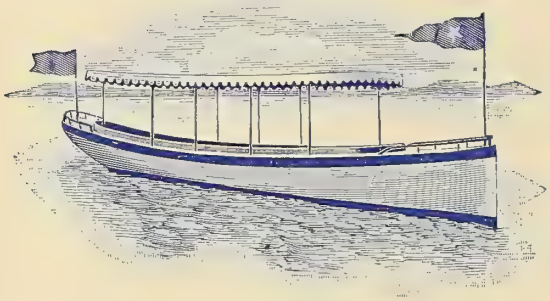
MURRAY & TREGURTHA, Foot of F Street, So. Boston, Mass.

ALCO VAPOR

Hunting Launch.

Sportsman's Floating Camp. Motor controlled from bow. Valve movement, 12 to 1. 16 to 60 ft. Launches. Twin Screws a specialty. 1, 2, 3, 5, 7, and 12 h. p. No licensed engineer or pilot required. Speed and Safety guaranteed. **No dangerous Naphtha or Gasoline used.** No disagreeable vibration. SEND TEN CENTS IN STAMPS FOR 1897 CATALOGUE.

MARINE VAPOR ENGINE CO., Foot Jersey Ave., Jersey City, N. J.



Yachts, Launches, Marine Machinery

OF EVERY DESCRIPTION.

We build complete

GASOLINE and STEAM POWER PLANTS.

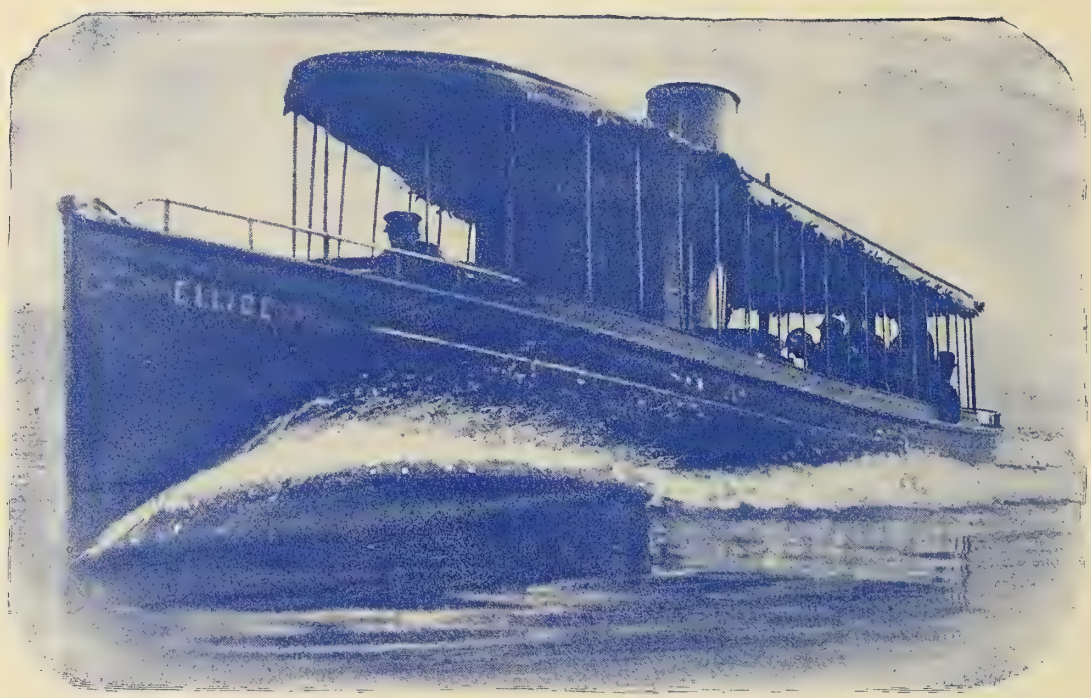
Our Gasoline Launches are in use by the Lighthouse Service.

We have no SECOND GRADES in HULLS or MACHINERY, as we build nothing but the BEST.

SEND SIX CENTS IN STAMPS FOR CATALOGUE.

THE POWER AND LAUNCH CO., BRIDGEPORT, CONN.

THE FASTEST YACHT IN THE WORLD.



STEAM YACHT ELLIDE—SPEED 40 MILES PER HOUR.

HIGH SPEED STEAM YACHTS A SPECIALTY.

SEND FOR ILLUSTRATED CATALOGUE. CHAS. D. MOSHER, 1 BROADWAY, NEW YORK.

"Shipped Set Up."

Size 4⅝ x 9 inches,
Including Binding Post.

A PERFECT GAS ENGINE BATTERY.

Long Life. Cannot Slop.
Will Not Break.
No Acids Used.

Ready for immediate use on addition of water. Send for catalogue.

THE ELECTRIC GAS LIGHTING CO.,
195 Devonshire Street,
BOSTON, MASS.

"KING"

Gasoline Engines.

NO OIL CUPS.

EXHAUSTS UNDER WATER. NOISELESS.

Complete Launches,
Yachts and Working Boats.

THE CHARLES B. KING CO., DETROIT, MICH.

No Fire, Smoke or Heat. Absolutely Safe. Catalogue Free.
TRUSCOTT BOAT MFG. CO., ST. JOSEPH, MICH.

IF YOU ARE GOING TO ALASKA FOR GOLD

Send stamp for Circular.

IF YOU are not going you want to know all about our Knock Down **BOATS** just the same.

We do the work, you nail together. Freight low.

AMERICAN KNOCK DOWN BOAT CO., ST. LOUIS, MO.

JAMES C. WIGNALL,

Boat Builder,

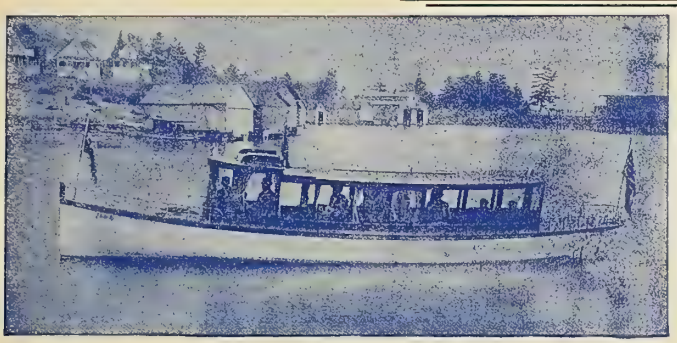
Beach and Vienna Sts.,
Kensington, Philadelphia.

Residence: 1025 PALMER STREET.

STEAM AND SAILING YACHTS, GUNNING, FISHING AND SPORTING BOATS

OF ALL DESCRIPTIONS BUILT TO ORDER.

WHY IS THE SINTZ MARINE ENGINE THE BEST?



Because it gives more actual power for the cost of running than any engine on the market. It occupies less space and weighs less per horse power. It does not require a flame to ignite the charge. It is absolutely safe. It is practically free from all valves, and has less than one-half as many parts as any other engine, and only three moving parts. It is clean—no dust, no dirt, no offensive odor and nothing to soil the clothes. It only requires half a minute to start, and runs equally as well in cold weather as in warm. It requires no government inspection, no licensed engineer or pilot

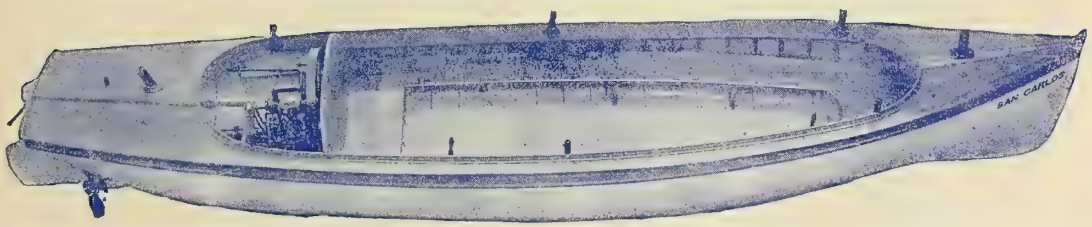
The best boat builders use these engines because they please their customers and sell themselves. Ask your boat builder, or write to us for catalogue.

The Sintz Gas Engine Co.,

GRAND RAPIDS, MICH.

Write for Catalogue.

Special Prices on Stern Paddle Wheel Engines for Light Draught Boats.



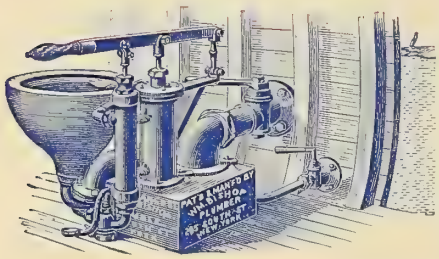
NOISELESS, FIRELESS, ODORLESS, ATTRACTIVE, INOFFENSIVE, INEXPENSIVE, NON-EXPLOSIVE, DURABLE, REVERSIBLE AND SAFE.

16-18-20 and 25-Foot **VAPOR LAUNCHES.** Price, $150, $165, $225, $375 and $475.

Carvel Build, Copper Fastened, Speed 6 to 9 Miles. Capacity 8 to 20 People. Larger Size to order. Price and Specifications upon Application. Also, all Sizes and Styles of Row and Sail Boats, Canoes, Dinghies, etc. Specialty of **HALF** and **ONE RATERS.** Send 8c. for Illustrated Catalogue to

Box D. RACINE YACHT & BOAT WORKS, Racine Junction, Wis.

PATENT PUMP WATER CLOSETS,



BRASS AND COPPER PUMPS, DECK PLATES,

SEA COCKS, TANKS, VENTILATORS AND OTHER

MARINE SPECIALITIES.

COPPERSMITHS,
STEAM FITTERS,
MARINE PLUMBING,

WM. BISHOP'S SONS,

205 SOUTH ST., NEW YORK. 724 THIRD AVE., BROOKLYN.

New York Telephone Call, 197 Franklin.

VESSEL MACHINERY AND SUPPLIES.

Windlasses, Capstans, Pumps, Steering Apparatus, Coaling Scuttles, Air Ports, Chocks, Cletes, Brass and Iron Castings, Etc.

MARINE MONITOR SIDE LIGHTS.

Made Either With or Without Storm Shutters.

CONTRACTORS' SUPPLIES.

Jack Screws, Crabs, Derrick Fixtures, Pile Mauls, Wheel Barrows, Crow Bars, Trench Pumps.

SHIP BUILDERS' SUPPLIES.

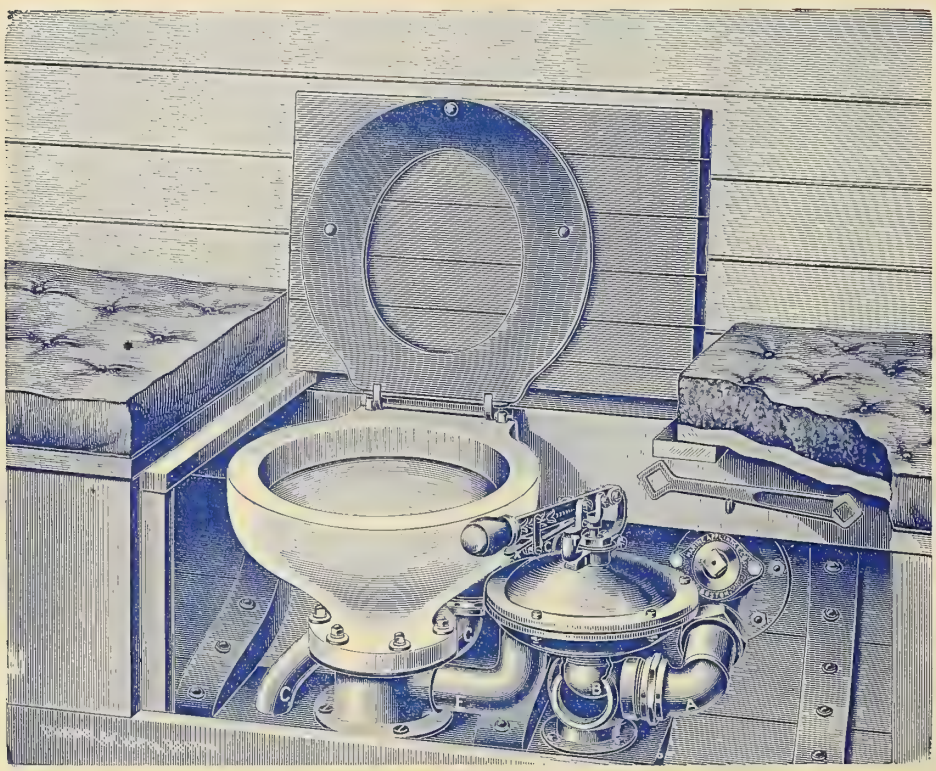
Oakum, Caulking Cotton, Deck Plugs, Pitch, Tar.

GENERAL LINE OF

Ship Chandlery, Marine Hardware, Cordage, Wire Rope, Yacht Supplies, Flags, Signals, etc.

MARINE MANUFACTURING & SUPPLY CO., 158 South St., New York.

The IMPERIAL PUMP CLOSET KNOCKABOUT Style



Especially adapted for Launches and Small Yachts. Only 11 inches high, and goes under the transom.

When the seat is down the closet is entirely concealed. For use either above or below the water line.

Send for Circulars.

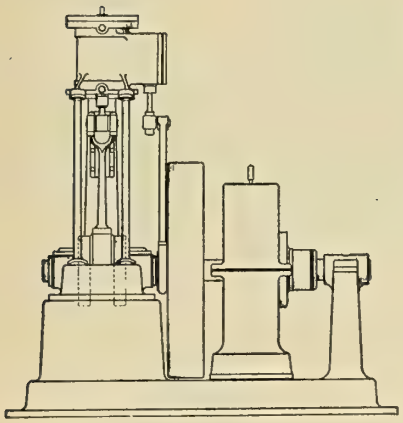
We also Manufacture

THE IMPERIAL Yacht Closet.

THE MARINE APPLIANCE CO.,

36 Oliver Street,
BOSTON, MASS.

CHARLES S. LINCH,

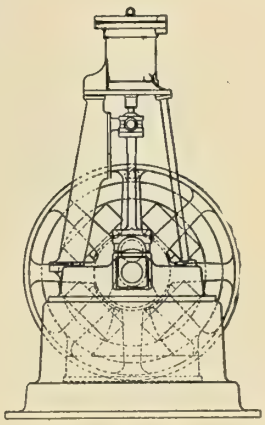


Mechanical and Marine Engineer,

935 Drexel Building,
1501 South Front Street,

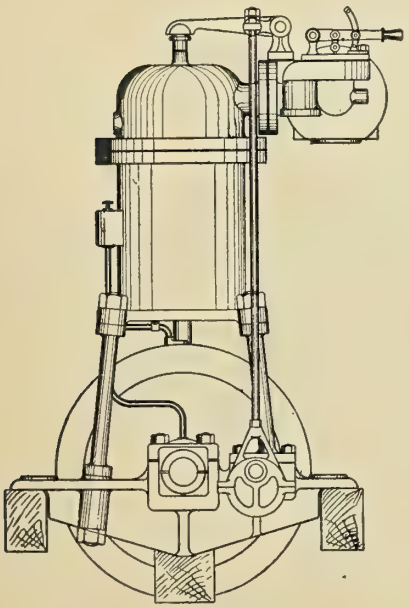
...PHILADELPHIA, PA...

Marine Engines,



HIGH SPEED SINGLE, COMPOUND,
TRIPLE AND QUADRUPLE EXPANSION,

FOR STEAM SHIPS AND YACHTS.



Marine Oil Engines

FOR LAUNCHES.

Single and Double Acting. From 2 H. P. Up.

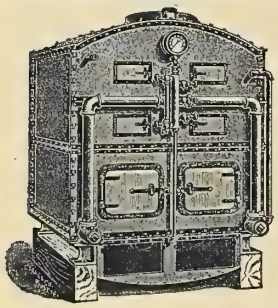
PROPELLER WHEELS.

COMPLETE MARINE OUTFITS

IN EITHER STEAM OR OIL.

CLARK'S PATENT SAFETY WATER TUBE BOILER.

For MARINE and STATIONARY WORK.



Now Used in a Number of Yachts, Launches and Passenger Steamers.

MANUFACTURED BY

EDWARD S. CLARK,

Nos. 272-278 Freeport St.,

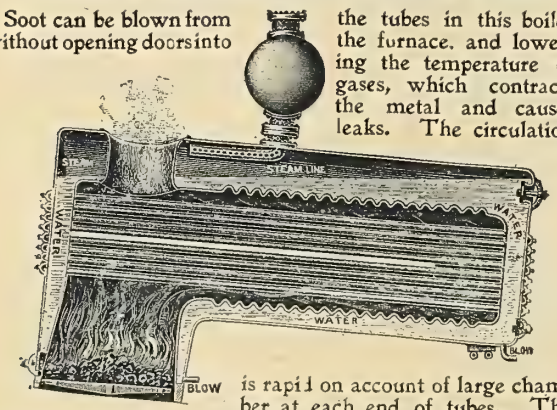
Harrison Sq., Boston, Mass.

THE TONKIN PATENT

INTERNALLY FIRED WATER-TUBE BOILER

For Marine or any Purpose where Steam is Required.

Soot can be blown from the tubes in this boiler without opening doors into the furnace, and lowering the temperature of gases, which contracts the metal and causes leaks. The circulation



BLOW is rapid on account of large chamber at each end of tubes. The boilers are in use where water is very bad. Still, the tubes are kept clean by the rapid circulation.

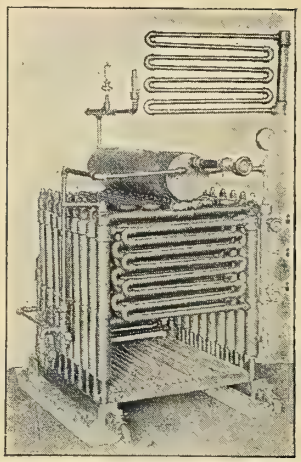
Eight tests showed from 11.985 to 14.660 pounds of water evaporated per pound of combustible from and at 212° F. We can save money for you.

Adapted to any pressure up to 500 pounds.

JOHN EATON,
President Oil Well Supply Co.,
PITTSBURG, PA.

JOHN J. TONKIN,
Room 609, Havemeyer Bldg.,
26 CORTLANDT ST., N. Y.

BRANCH OFFICES:
15 Federal Street, Boston, Mass., W. H. Bailey, Manager.
54 Manufacturers' Record Bldg., Baltimore, Md., John H. Buxton, Manager.



THE BUCKLEY PATENT

SAFETY WATER TUBE BOILER

FOR

Boats and Yachts.

No Left Hand Threads in this Boiler.

For Catalogue and Prices address

ROCHESTER MACHINE TOOL WORKS,
20 Frank Street,
ROCHESTER, N. Y.

Thornycroft Water-Tube Boiler.

450,000 Horse Power in Use.

Nine United States Torpedo Boats fitted, also the Pennsylvania Railroad Ferry Boats "New Brunswick" and "Philadelphia."

Highest Efficiency, Maximum Power, Minimum Weight and Space. From their light weight and great efficiency they are the best boiler to substitute for the old cylindrical boiler.

THORPE, PLATT & CO.,

99 CEDAR ST., NEW YORK.

ALMY WATER-TUBE BOILER CO.

MANUFACTURERS OF

Almy's Patent Sectional Water-Tube Boilers

For Marine and Stationary Work,

NOS. 178 TO 184 ALLENS AVENUE (between Rhodes and Public Streets),

TAKE EDDY ST. CAR.
LONG DISTANCE TELEPHONE.

Providence, R. I.

MAGNESIA SECTIONAL COVERING

The ONLY Genuine Magnesia. Others so-called are FRAUDULENT.

Over 85% Carb. of Magnesium

USED ON

Nine-tenths of the U.S. Government vessels.

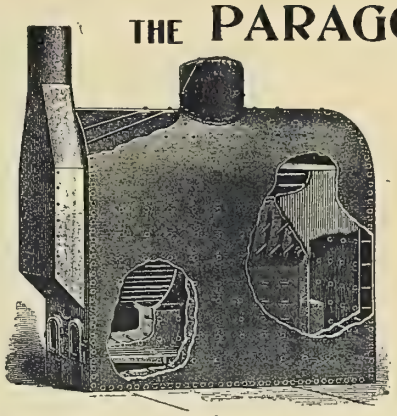
More High-Class Yachts than All Other Coverings Combined.

All leading S. S. S. B., Towing and Dredging Lines, etc.

Send for References, Tests, Prices, etc., etc., to

43 TERRACE, BUFFALO. ROBERT A. KEASBEY, 54 WARREN STREET, NEW YORK.

THE PARAGON BOILER



Patent issued in United States, Jan. 25, 1898. Patented in Canada, Jan. 29, 1898.

FOR MARINE OR STATIONARY PURPOSES

It is said by prominent Marine Boiler Makers TO BE THE BEST BOILER EVER INVENTED.

Waste no more money heating Asbestos Casings or expensive Brick Walls, which NEVER BOIL WATER.

CORRESPONDENCE SOLICITED

CAPT. M. DEPUY, Patentee and Sole Agent, Office, 19 South Street, New York.

KINGSFORD BOILER WORKS, *OSWEGO, N. Y.*

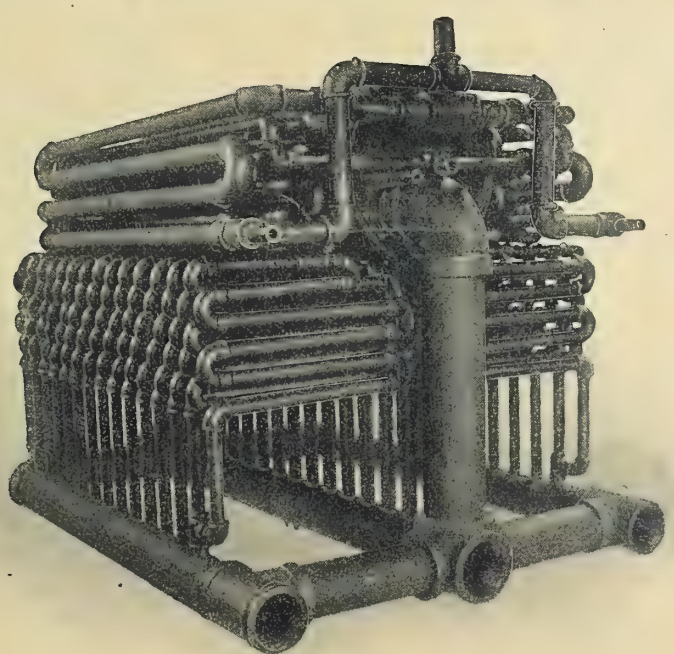
Marine Boilers of every description designed and constructed on short notice. Estimates given.

Best Material.
High Class Workmanship.
Reasonable Prices.

Special Types of Marine Boilers for Steam Yachts, Passenger Steamers, and Tugs.

Kingsford Foundry and Machine Works,
OSWEGO, N. Y.

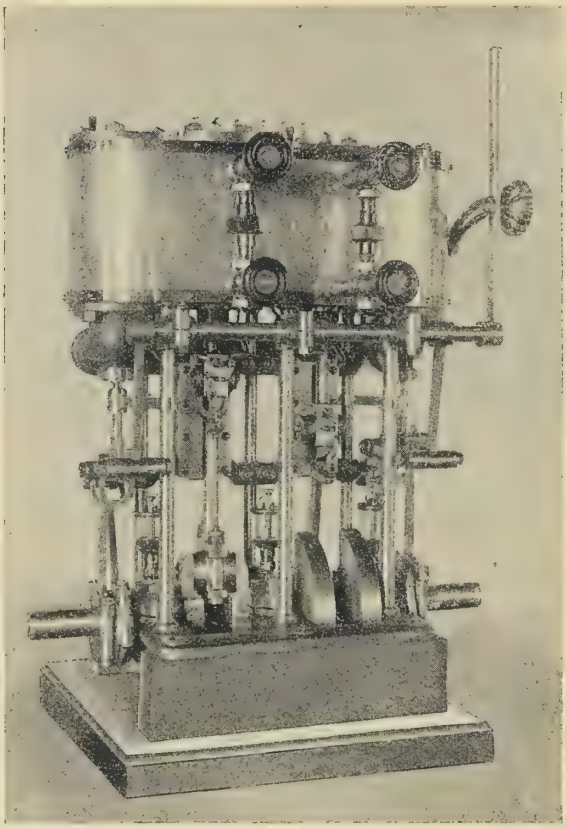
DEARING WATER TUBE BOILER



For Marine and Stationary Use . . . .
Perfect Safety with Highest Pressure . .
Highest Efficiency with High or Low Pressure . . . . .
Steady and Reliable Water Line . . . .

DEARING WATER TUBE BOILER CO., Detroit, Mich.

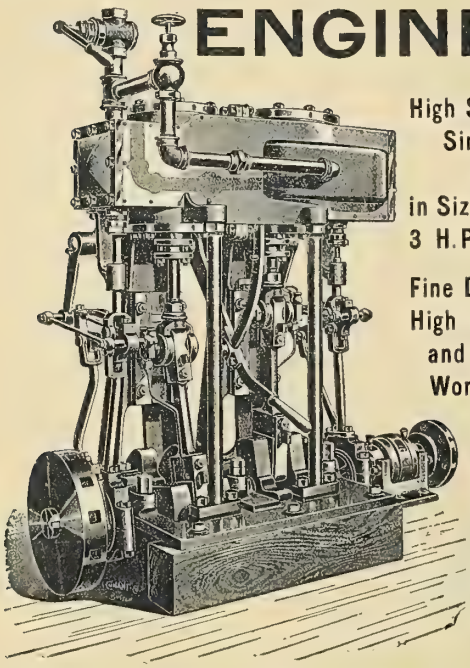
Yacht, Blower AND Electric Light Engines



In Stock OR In Progress AT All Times Compound and Single.

W. D. FORBES & CO., Hoboken, N. J.

MARINE ENGINES,



High Speed, Single and Compound, in Sizes from 3 H.P. upwards.

Fine Design, High Finish and First-class Workmanship.

Large Accessible Bearings with Automatic Lubrication Light but Strong Construction.

Moderate Prices.

Write for Circulars.

MORRIS MACHINE WORKS,

BALDWINSVILLE, NEW YORK.

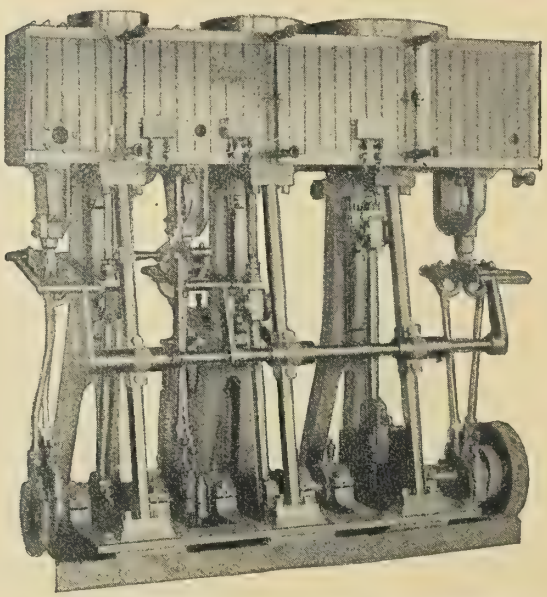
New York Office, 39 & 41 Cortlandt Street.

Marine Engines

AND MACHINERY FOR YACHTS, PASSENGER BOATS AND TUGS.

Also makers of the well known

- - - PAINE PROPELLER WHEEL. - - -



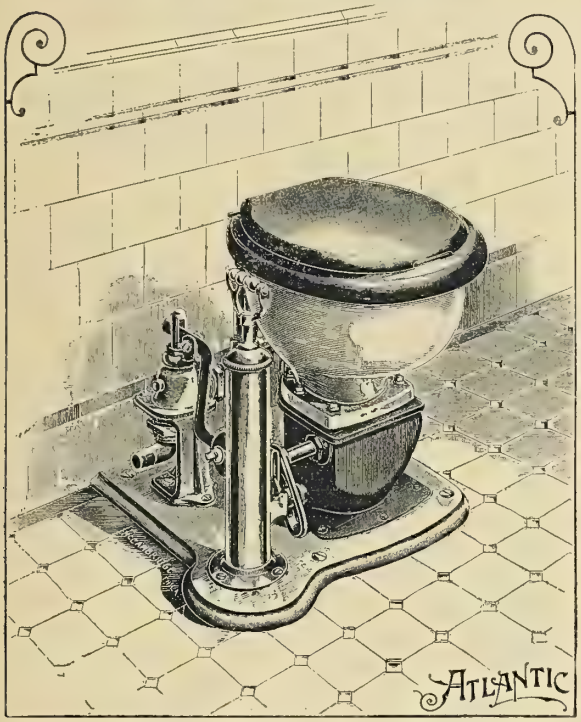
Long Distance Telephone. **Your Inquiries Solicited.**

JAMES H. PAINE & SON,

Clor. Cayton and Park Sts., BOSTON, MASS.

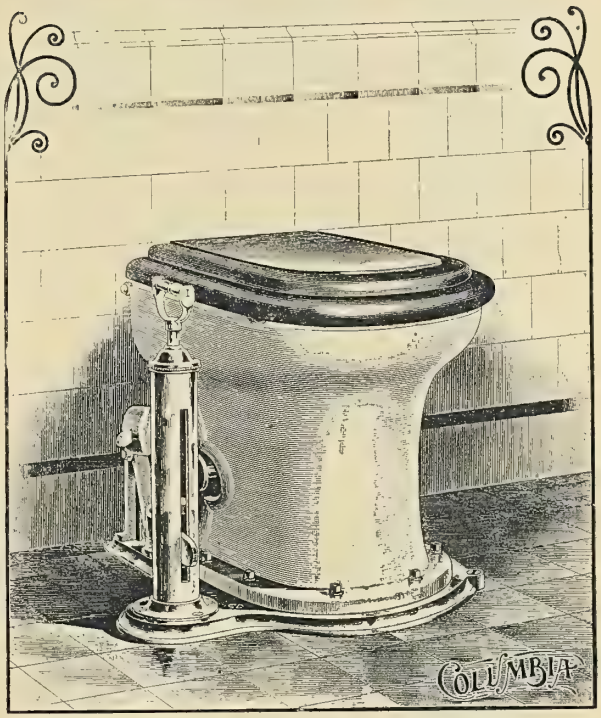
SHIP and YACHT WATER CLOSETS and LAVATORIES.

PUMP WATER CLOSET.
Patented in the United States and Great Britain.



ONE LEVER DOES THE WORK.

SINGLE VALVE WATER CLOSET.



The "Neptune" and "Columbia" are the Finest Ship Water Closets in the World
BOTH ARE USED BY THE UNITED STATES GOVERNMENT.

FOLDING LAVATORY.

We manufacture a large line of both house and ship plumbing goods.

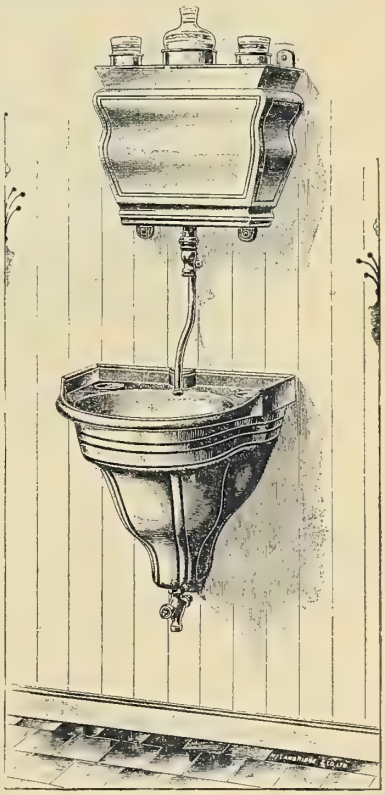
WATER CLOSETS,
BATH TUBS,
LAVATORIES,
BRASS COCKS,
VALVES and
FITTINGS,

and execute to order
SPECIAL BRASS WORK.

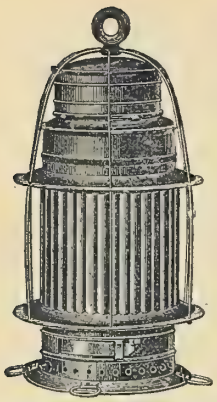
McCAMBRIDGE & CO., LTD.,

523, 525 & 527 Cherry Street,
PHILADELPHIA, PA., U. S. A.

Catalogue and Prices upon Application.



OPEN LAVATORY.

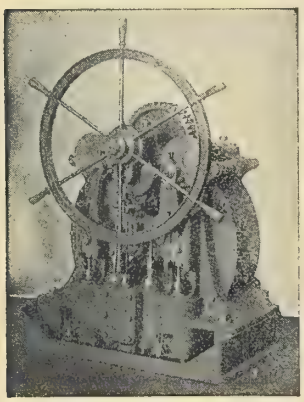


EVERYTHING
...IN...
Marine Lamps.

SHALL WE SEND YOU OUR CATALOGUE?

RUSSELL & WATSON, 145 Main St., Buffalo, N. Y.

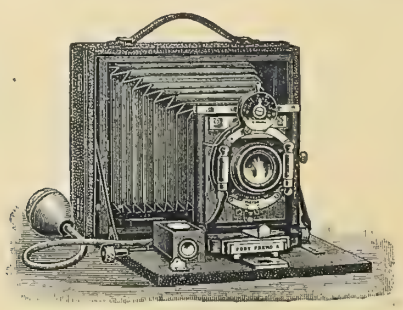
BECK'S PATENT
STEERING GEAR.



Steam and Hand.
Built in all Sizes.
Simplest, Strongest, Most Reliable.
Changed from Steam to Hand or back by One Lever in less than One Second.

BUILT BY
PAWLING & HARNISCHFEGER,
MILWAUKEE, WIS.

TO ENGINEERS



THE Premo Camera

Will be found valuable in making reports of the progress of work on a contract. A photograph conveys a more definite idea than the longest written description.

Furnished with our New Victor Lens and Shutter.

Send Your Address for Illustrated Catalogue.

ROCHESTER OPTICAL CO., ROCHESTER, N. Y.

MARINE LAMPS

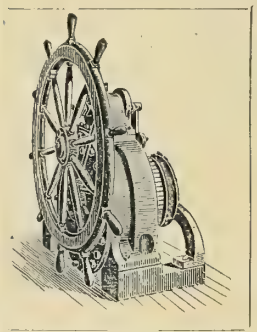
Oil and Electric.

Signals, Fixtures, Etc.

WM. PORTER'S SONS,

271 PEARL STREET, NEW YORK.

Queen City Patent Hydraulic Steerer.



THE BEST AND MOST RELIABLE.
GENERATES NO HEAT IN PILOT HOUSE.

Has Large Hand Wheel.
Can be Changed from Power to Hand Steering Instantly.
A Favorite with Pilots.

SEND FOR REFERENCES.

QUEEN CITY ENGINEERING CO.,
BUFFALO, N. Y.

12,000 in Use.

Unaffected by Weather. Portable, Self Contained.

800 to 4000
CANDLE POWER FROM
KEROSENE OIL.

Especially adapted for Contractors, Quarries, Shovels, Railroad Construction, Dredges, Bridge and Dock Builders, Water Works, Brick Yarks and Coal Docks.

400 RAILROADS and over 500 CONTRACTORS NOW USE THE WELLS LIGHT.

THE WELLS LIGHT MFG. CO.,
EDWARD ROBINSON, Sole Proprietor.
46 Washington St., New York.

PATENTS SECURED.

Inventors desiring to secure full information in regard to the necessary course to pursue to obtain a patent, should send for our booklet on the subject.

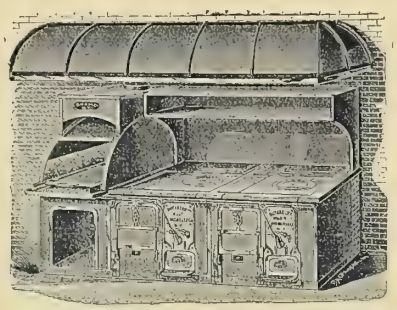
MAILED FREE TO ANY ADDRESS.

PATENT DEPARTMENT:

THE POWER PUBLISHING CO.,

WORLD BUILDING, NEW YORK.

FRENCH & COOKING & RANGES,



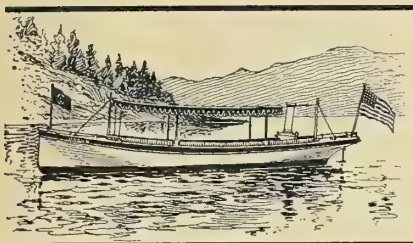
and Cooking Apparatus of every description for Steamships, Yachts, etc.

Established 1852.

Branch Salesrooms
79, 81, 83
Market Street,
Chicago, Ill.;
6 Union Street,
Boston, Mass.

DUPARQUET, HUOT & MONEUSE CO.

Office and Warerooms: 43 & 45 Wooster St., New York City.



THE ONLY NAPHTHA LAUNCH.

Nearly 3,000 in use. The Safest, Simplest, Speediest power boat. Superiority demonstrated by ten years' experience. & &

Send 10c. stamp for Catalogue.

GAS ENGINE & POWER CO., AND CHARLES L. SEABURY & CO.,
Consolidated.

MORRIS HEIGHTS, NEW YORK CITY.

HOLMES, BOOTH & HAYDENS,
WATERBURY, CONN.
NEW YORK OFFICE: 37 PARK PLACE.

Seamless Brass and Copper Tubing
for condensers, heaters, steam pipes and other coppersmith work.
Also **Sheet Brass and Copper.**

U. T. HUNGERFORD.
GEORGE DAVIDSON.
BERNARD RIS.
J. R. VAN BRUNT.

TELEPHONE,
259 FRANKLIN

U. T. HUNGERFORD,

Brass and Copper,

121 Worth St., between Centre and Elm Sts., New York.

SEAMLESS BRASS AND COPPER TUBING

For Condensers, Heaters, Steam Pipes and Coppersmiths' Work generally.

SHEET AND BOLT COPPER.

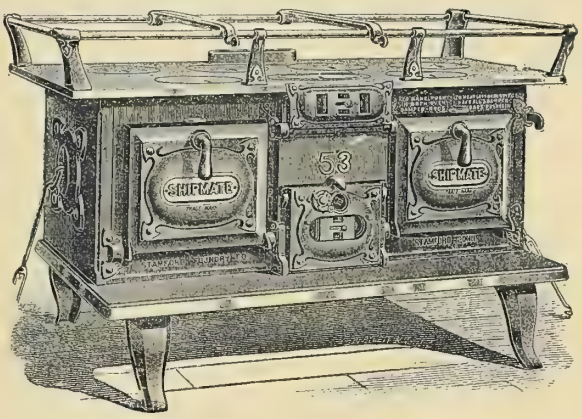
YELLOW METAL SHEATHING, BOLT AND NAILS.

BRASS AND COPPER

In every Variety of Shape and Form.

We carry a large stock of all above goods on hand for prompt shipment.

Catalogues and Prices Submitted on Application.



No class of Range trade requires more prompt and careful attention than the vessel trade, and we give it just that kind of attention.

We have the Ranges and Repairs always in stock, and we ship on receipt of order.

Ask dealers and captains if they have ever had any different experience with us.

THE STAMFORD FOUNDRY COMPANY,
STAMFORD, CONN.

Established 1830.

DRY DOCKS.

TEBO'S
YACHT BASIN, COALING STATION AND FLOATING DRY DOCKS,
Foot 23d Street, BROOKLYN.

BROOKLYN
FLOATING DOCK AND SHIPYARD.
THEO. A. CRANE'S SONS, PROPRIETORS,
Erie Basin, South Brooklyn.
CAPACITY OF DOCK, 1200 TONS. LENGTH OF KEEL BLOCKS, 200 FEET.
Telephone, 236 Hamilton.

JAPAN PAINTS HAVE NO EQUAL FOR
BRILLIANCY, GLOSSINESS, DURABILITY.
....ALL COLORS....
Where applied the surface becomes coated as with glass, resisting the influence of weather, water (fresh or salt), and keeps its gloss for years.
The American Greyhounds and other crack Ocean Steamers, and numerous Yachts and Ferry Boats are painted with it.
For all kinds of House Painting (Indoors and Outdoors), Railroad Tramcars, Wagons, and all kinds of Iron Structures and Machinery; in fact, everywhere and everything, where you want something
BEAUTIFUL AND LASTING.
EDWARD A. BUNKER, Sole Agent,
20 Broad Street, - - - NEW YORK.

LEWIS NIXON, Office and Works:
Shipbuilder. Elizabethport, N. J.
BUILDER OF STERN WHEEL, PADDLE AND SCREW
Steamers, Torpedo Boats and Barges OF ALL KINDS IN STEEL.
A SPECIALTY MADE OF
South American and Alaskan River Boats.

Marine Engineering can supply any book devoted to Marine Matters.

GEORGE W. PIPER,
IMPORTER AND MANUFACTURER OF
ENAMELS AND PAINTS FOR YACHTS AND STEAMSHIPS.
SOLE SELLING AGENT FOR THE U. S. FOR **McINNES'S**
(ENGLISH) COMPOSITIONS
FOR THE BOTTOMS OF IRON AND STEEL SHIPS.
MANUFACTURED BY
JOHN McINNES & SON, Liverpool, England.
Office, 55 South St., New York.
Telephone Call, 1326 Broad.
Beware of imitations that are being sold on the market as the McInnes'.

FRANKFORD STEEL COMPANY, ELLWOOD CITY, LAWRENCE CO., PA.
STEEL FORGINGS, HEAVY SHAFTINGS.
In the Rough, Rough Turned or Finished. **Office, Fidelity Mutual Building, PHILADELPHIA.**

BURDEN IRON CHAIN, AMERICAN CHAIN CABLE WORKS.
The J. B. Carr Company, Troy, N. Y.,
Manufacturers of
CABLE, SHIPPING, CRANE, DREDGE, STEERING, QUARRY, and RAFTING CHAINS.
All Chains and Cables made of Especially Rolled Iron and Warranted to Stand Government Test.

NICKEL STEEL:
Crank-pins, Crosshead Pins, Piston Rods and Main Axles
OF FLUID COMPRESSED ACID OPEN HEARTH NICKEL STEEL, ANNEALED OR OIL TEMPERED.
...Manufactured by...
100 Broadway, New York.
142 Chestnut St., Philadelphia.
Marquette Building, Chicago, Ill.
The Bethlehem Iron Company,
South Bethlehem, Penna.

The Charles Hillman Ship and Engine Building Co.

Beach above Palmer St., Philadelphia.

THE CHICAGO SHIP BUILDING COMPANY,

SHIP BUILDERS and ENGINEERS,

CHICAGO.

THE CLEVELAND SHIP BUILDING CO.

...Steel Ships...

Marine Engines AND Boilers.

T. S. MARVEL & CO., NEWBURG, N. Y.

Ship and Engine Builders.

The Atlantic Works,

BORDER, MAVERICK and NEW STS., EAST BOSTON, MASS.

(Docks opposite Navy Yard.)

Builders of

STEAMSHIPS, TOW BOATS AND STEAM YACHTS,

IN STEEL AND WOOD.

Marine Engines, Boilers, etc. Hull, Boiler and Engine Repairs.

Cramp's Ship Yard,

PHILADELPHIA, PA.

Battle Ships, Cruisers, Passenger and Freight Steamships, etc.

STEAM MACHINERY of every description, including boilers and all equipment; Marine Engines of any desired power Gun Carriages, Basin Dry Dock and Marine Railway, Parsons' Manganese Bronze and White Brass, Water Tube Boilers (Niclausse, Mosher, Yarrow).

AREA OF PLANT, thirty-two acres. Area covered by buildings, fifteen acres. Delaware river front, 1,543 feet.

FLOATING DERRICK "ATLAS": capacity 130 tons, with 60 feet hoist and 36 feet out-hang of boom.

NUMBER OF MEN EMPLOYED, about 6,000 in all departments.

NEWPORT NEWS SHIPBUILDING & DRY DOCK CO.

WORKS AT NEWPORT NEWS, VA.

(ON HAMPTON ROADS.)

Equipped with a Simpson's Basin Dry Dock capable of docking a vessel 600 feet long, drawing 25 feet of water, at any stage of the tide. Repairs made promptly and at reasonable rates.

SHIP AND ENGINE BUILDERS. : : *For estimates and further particulars, address*

C. B. ORCUTT, Pres't, No. 1 Broadway, New York.

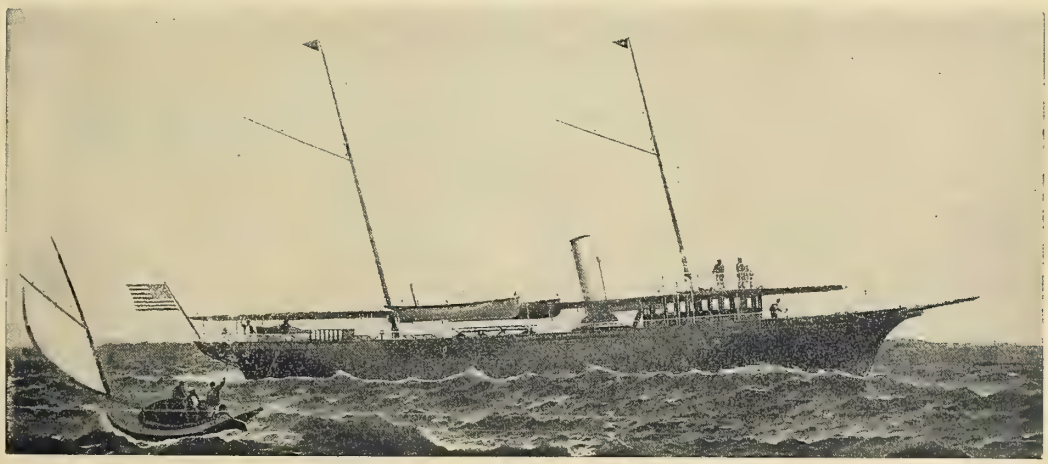
15 to 200 H. P. Compound Engines carried in stock for immediate delivery.

Balanced Compounds and Quadruples of large power built on order.

Steam vessels of all descriptions built. : :

WELLS ENGINEERING CO.,

136 Liberty St New York, U. S. A.



ROACH'S SHIPYARD.

The Delaware River Iron Shipbuilding and Engine Works,

CHESTER, PA.

BUILDERS OF STEAMSHIPS AND MARINE MACHINERY
FACILITIES FOR WORK OF EVERY DESCRIPTION. . . .

Hulls, Engines, Boilers and Fine Woodwork.

Refer with pleasure to the vessels of the Mallory Line, the Old Dominion Line, the Pacific Mail Steamship Company, the New York and Cuba Mail Steamship Company (Ward Line), the Fall River Line, Savannah Line, Columbian Line, Maine Steamship Company, Pacific Coast Steamship Company, Standard Oil Company, Pennsylvania Railroad Company, New London Steamboat Company, Iron Steamboat Company, Chester Freight Line, and others; United States Cruisers Chicago, Boston and Atlanta; Dispatch Boat Dolphin; Gunboats Concord and Bennington; Monitors Puritan and Miantonomoh.

NOW BUILDING:

No. 293, Steamship "Horatio Hall," 320 feet long, 46 feet beam 3,300 tons register, 4,500 horse-power, speed 19 knots, for Maine Steamship Company.

No. 294, Yacht for Gardner & Cox; length 150 feet, beam, 20 feet, horse-power 750, speed, 18 knots.

No. 295, yacht similar to above for private account.

No. 296, steamer "Cape Charles," 233 feet long, 41 feet beam, 1,500 horse-power, speed 18 miles, for New York, Philadelphia and Norfolk Railroad.

No. 297, Oil Tank Steamer for Standard Oil Company. Length 264 feet; capacity 720,000 gallons of oil; horse-power 1,800. The largest tank steamer ever built in this country.

No. 298, Ferryboat "Philadelphia," for Pennsylvania Railroad Company's Twenty-third street ferry, New York. 206 feet long. Two-decks, double-ended, with twin screws driven by two engines 1,200 horse-power each.

GENERAL OFFICE AND WORKS:
CHESTER, PA.

NEW YORK OFFICE:
MORGAN IRON WORKS, Foot East Ninth St.

Established 1863. Incorporated 1867.

THE.....

Harlan & Hollingsworth Company,

Wilmington, Delaware, U. S. A.,

SHIP BUILDERS.

Iron and Steel Vessels of all Kinds.

Engines, Boilers and Machinery Generally.

Torpedo Boat Destroyers.

STEAM AND SAILING

YACHTS

OF THE HIGHEST CLASS.

A Simpson Patent Basin

DRY DOCK

of 340 Feet Length and 14 Feet of Water.

SPECIAL DESIGNS AND SPECIFICATIONS.

Seamless Cold Drawn Steel Boiler Tubes.

UNEXCELLED IN

STRENGTH, DURABILITY and EFFICIENCY.

MANUFACTURED FROM SOLID ROUND BAR.

Free from all Porousness and Physical Imperfections.

NO LAPS OR SEAMS OR WELDS.

Made from the Highest Grade of Material. Sulphur and Phosphorus Guaranteed not to exceed .025%.

CAN BE WELDED LIKE IRON.

DOES NOT PIT OR CORRODE like lap-welded tubing.

DOES NOT SPLIT OR CRACK when being expanded or re-rolled in tube sheet.

TUBES ARE VERY TOUGH and of increased density, owing to the cold drawing, and expanded tube ends hold tighter in tube-sheet than lap-weld tube.

TUBES ARE TRUE TO SIZE AND GAUGE and have very smooth inside and outside finish. This admits of much closer shop work than where lap-welded tube is used.

TUBES ARE MUCH EASIER CLEANED than lap-welded, as the scale does not adhere so tightly to smooth surfaces as that of the lap-welded tube.

SEAMLESS TUBING CAN BE BENT into all kinds of shapes and with short radii without fear of failure, and has remarkable ductile and flanging properties.

The increased strength admits of higher steam pressure without decreasing of factor of safety.

CORRESPONDENCE SOLICITED.

Send us a sample order and verify the above statements.

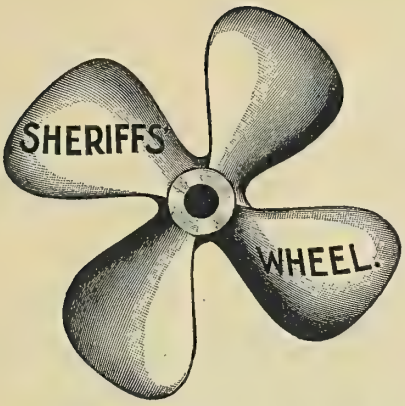
Shelby Steel Tube Co., *GENERAL SALES OFFICE,* American Trust Bldg., CLEVELAND, O.

MILLS:
Ellwood City, Pa. Shelby, Ohio.
Greenville, Pa. Toledo, Ohio.

EASTERN OFFICE AND WAREROOMS:
No. 144 Chambers St.,
New York, N. Y.

EUROPEAN OFFICE AND WAREROOMS:
29 Constitution Hill,
Birmingham, Eng.

WESTERN OFFICE AND WAREROOMS:
135 Lake St.,
Chicago, Ill.



Sheriffs Manufacturing Co.,
MILWAUKEE, WIS.

Paul S. Reeves & Son,

PHILADELPHIA,

Manufacturers of

Propeller Wheels

in all the BRONZES.

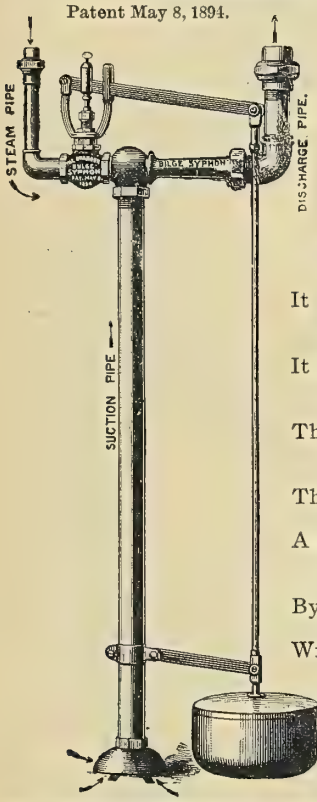
Marine Castings a Specialty.

Phosphor-Bronze, Brass, Babbitt Metals.

Castings from ¼ to 10,000 lbs. Weight.

THE BRAENDER AUTOMATIC BILGE SIPHON.

Patent May 8, 1894.



ALWAYS ON WATCH.

"SHIP AHOY."

It never tires, or goes to sleep, and is reliable at all times.
It is the best, cheapest and surest way of keeping your vessel dry.
They are endorsed by leading Engineers throughout the country.
They commend themselves wherever placed.
A dry bottom in ships' holds gains speed which is equal to money.
By giving it a trial, it will speak for itself.
Write for circular.

PHILIP BRAENDER,
47 West 125th Street,
Between Fifth and Lenox Avenues. NEW YORK.

We Manufacture a Complete Line of

BRASS SIDELIGHTS.

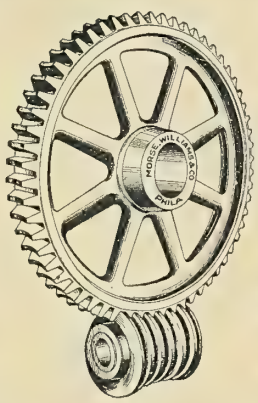
ALSO

THE "CORRECT" AUTOMATIC STEAM FLUE CLEANER.

WRITE FOR TERMS.

VIADUCT BRASS WORKS,
34 Center Street, CLEVELAND, OHIO.

CHAS. A. CLAFLIN, Eastern Agent,
235 Franklin Street, Boston, Mass.



HINDLEY WORM GEARING

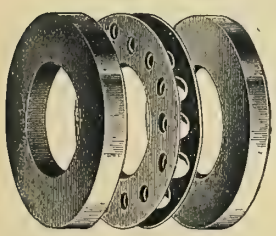
Gives the greatest efficiency and minimizes power expenditure.

MANUFACTURED BY
MORSE, WILLIAMS & CO.,
PHILADELPHIA, PA.
Write for descriptive Circulars and Prices.

BALL THRUST COLLARS

...FOR...

PROPELLER SHAFTS.



THEY CANNOT HEAT. *HUNDREDS HAVE*
THEY SAVE POWER. *BEEN APPLIED BY*
THEY ARE DURABLE. *LEADING BOAT BUILDERS.*

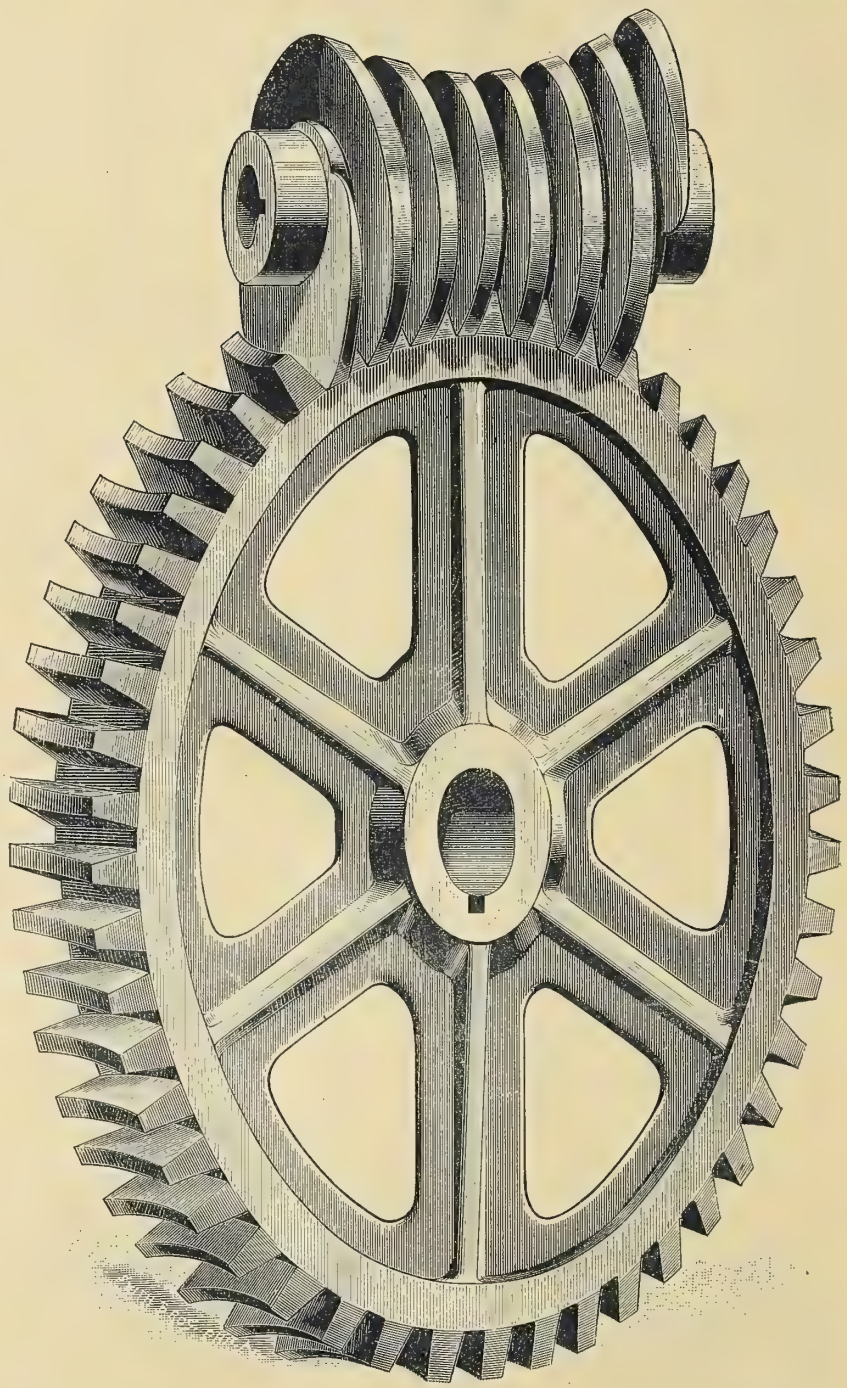
THE BALL BEARING CO.,
7 WATSON STREET, BOSTON, MASS.

WRITE FOR CATALOGUE.

New York Office: American Tract Society Building.

HINDLEY AND ALBRO ....WORM GEARING.

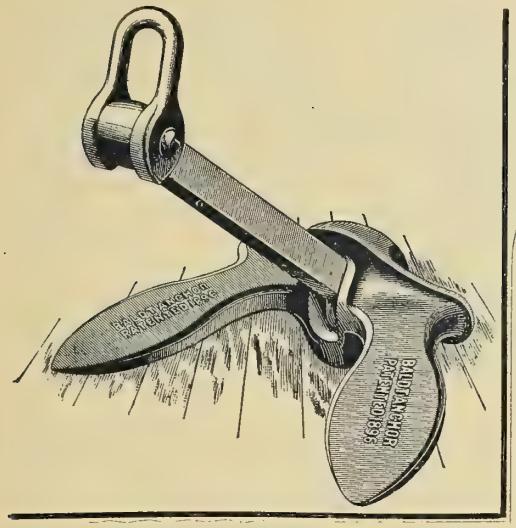
THESE WORMS AND WORM GEARS ARE ADOPTED BY THE U. S. GOVERNMENT FOR CRUISERS AND BATTLESHIPS.



Consumes Less Power and Gives Better Results Than Any Other Worm Gearing.

THE ALBRO-CLEM ELEVATOR COMPANY

SEVENTH STREET AND GLENWOOD AVENUE, - PHILADELPHIA, PENN.



BALDT PATENT STOCKLESS ANCHOR

MADE OF THE FINEST QUALITY OF OPEN-HEARTH STEEL.

Many points of superiority over ordinary Stockless Anchors.

Can be stowed in hawse pipe or carried on deck.

Anchors equipped with balancing and buoy shackles when so desired.

TESTS

The following Tests are employed to insure the highest grade of steel being used in the Baldt Stockless Anchors:

1—Test bars, taken from each heat, must show 60,000 to 70,000 lbs. tensile strength, with 15 to 25 per cent. elongation in eight inches.

2—A test bar one inch square is required to bend cold to an angle of 90 degrees.

3—No metal must run above .06 in phosphorus and .05 in sulphur.

4—Every anchor is subjected to a drop test of 10, 20, 30 and 40 feet on a hard macadamized bed.

All Anchors in heats varying in any particular from the above specifications are rejected.

BALDT ANCHOR CO.,

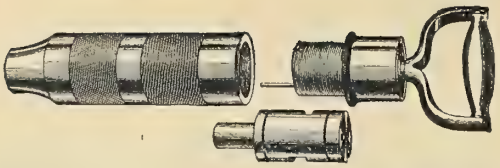
CHESTER, PA., U. S. A.

Write for Pamphlet entitled Perfection in Anchors.

BRANCH OFFICES.

THOS. PRICE, 136 Liberty St., New York City.

WALTER MILLER, 310 Western Reserve Bldg, Cleveland, Ohio.



It has only three parts. Cannot get out of order. We Guarantee it for two years.

THE CLEMENT PNEUMATIC TOOL COMPANY,

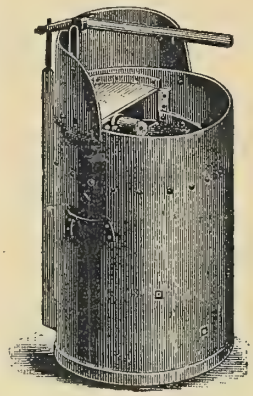
123-125 South Eleventh St., PHILADELPHIA, PA.

PNEUMATIC TOOLS

and Appliances for Chipping and Caulking Boilers and Ships.

REFERENCE:—Wm. Cramp & Sons, Ship and Engine Building Co., Philadelphia, Pa.

Catalogue on Application.



THE CRUMLISH

PORTABLE FORGE

FOR RIVET HEATING.

The strongest, lightest and handiest forge on the market. Constructed of steel, circular in form; weighs only 90 pounds; 19 inches in diameter. Used by the leading steamship companies and shipyards of the United States.

SEND FOR CIRCULAR.

The Crumlish Forge Co.,

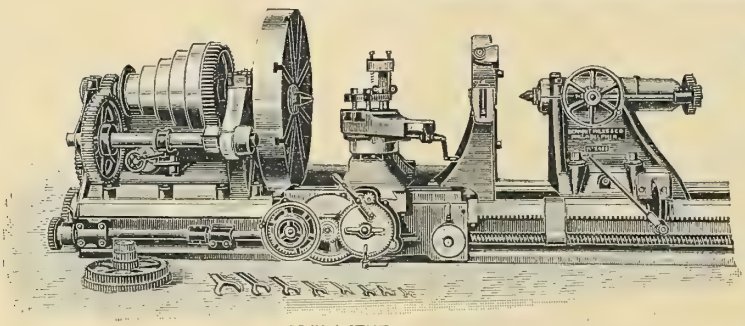
BUFFALO, N. Y., U. S. A.

BEMENT, MILES & CO.,

PHILADELPHIA, PA.,

Manufacturers of

METAL WORKING MACHINE TOOLS



63 IN. LATHE

For Shipyards, Boiler Shops, and all kinds of

METAL WORKING ESTABLISHMENTS.

NEW YORK OFFICE: Taylor Bldg., 39 Cortlandt Street.

Chicago Office, 1534 Marquette Bldg.

Armstrong's Tools *FOR MARINE WORK ARE THE BEST.*

No. 2 Stock.

Our Stocks and Dies are the acknowledged Leaders of the world.

Can be adjusted to the variations in the size of fittings. Work easier and accomplish the desired results in less time than solid dies. Our No. 2 Stock can be fitted with dies for threading either iron or brass pipe or bolts, and the No. 1 Stock either iron pipe or bolts.

New No. 3 Pipe Cutter.

Armstrong's Pipe Threading and Cutting Off Machines.

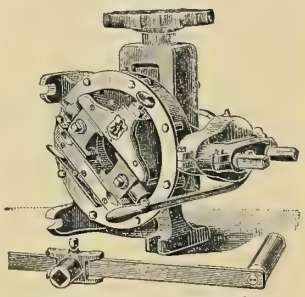
SIZES 1-8 TO 6 INCHES. HAND OR POWER.

No. O Theads Pipe from 1-8 to 2 inches. No. 1 Threads and Cuts Pipe 1 to 3 inches. No. 3 Threads and Cuts Pipe 1 to 6 inches.

Our No. O Machine works with greater ease and rapidity than any other Pipe Threading Machine ever offered. Has two speeds, one for pipe ⅛ to 1 inch, the other for pipe 1¼ to 2 inches, inclusive. Threads bolts and conduit pipe as well as iron or brass pipe.

ARMSTRONG'S IMPROVED PIPE VISES, PIPE WRENCHES, PIPE CUTTERS, CLAMP TAP, ETC.

Our tools are of the highest grade, and are celebrated for their time an labor-saving qualities. **GOT A CATALOGUE?**



No. O Threading Machine. Our Latest.

THE ARMSTRONG MFG. CO.,

New York Office, 139 Centre Street. **BRIDGEPORT, CONN.**

U. MAY 9 1898 S.
PATENT OFFICE.

MARINE ENGINEERING.

Vol. 2. NEW YORK, MAY, 1898. No. 5.

LAUNCH OF THE UNITED STATES BATTLESHIPS KEARSARGE AND KENTUCKY.

The launch of the United States Battleships Kearsarge and Kentucky at the Newport News shipyard on March 24, was in many respects of special technical interest. Not only was it the first time that two battleships had been put into the water at the same yard on the same day, but the vessels were the heaviest ever launched in this country and are of unusual type; and besides the launch presented several peculiar points in practice.

It was very desirable that the draught of these vessels should be kept as small as possible on account of the shallowness of most of our harbors, and on this account Commodore Philip Hichborn, Chief of the Bureau of Construction and Repair, recommended that their largest guns should be only 12 in. in caliber instead of 13 in. as in the "Indiana" class. Ensign Straus proposed, and the Bureau of Ordnance adopted and advo-

LAUNCHING THE FIRST-CLASS BATTLESHIP KENTUCKY AT NEWPORT NEWS SHIPYARD.

Copyright, 1898, by Marine Publishing Co., New York.

cated, the novel idea of two double decked turrets to each ship. In the lower part of each were to be mounted two 13-in. guns, and in the upper part two 8-in. guns.

A very vigorous discussion of the merits of this scheme raged in the newspapers and in the technical press for some time without much advantage to either side. The Department adopted the idea for these ships, but we note that in later designs it has been abandoned.

The general dimensions of the two ships are as follows:

Length on load water line	368 ft.
Beam, extreme	72 ft. 2.5 in.
Freeboard, forward	14 ft. 3 in.
Freeboard, aft	12 ft. 3 in.
Normal coal supply	410 tons
Mean draught, with coal on board	23 ft. 6 in.
Corresponding displacement	11,500 tons
Speed per hour	16 knots
Maximum coal supply	1,210 tons
Draught with 1,210 tons of coal and all stores and ammunition aboard	25 ft.
Corresponding displacement	12,325 tons

The armor protection presents points of difference from our previous first-class battleships. The water line belt of Harveyized nickel steel extends from the stem to the after barbette, instead of between barbettes only. Between barbettes its maximum thickness is 16 1-2 in. Forward of the forward barbette it tapers gradually to a thickness of 4 in. at the bow. The turret armor, instead of being of uniform thickness, is 2 in. thicker in front than elsewhere.

Each of these ships has on each side a docking keel extending from the center of the forward turret to the center of the after turret, to aid in taking the weight of the ship in dry dock. The keels in section are not unlike the letter H. The outer portion is to be filled with creosoted Indian teak. The teak has been fitted in place, but was taken out and is now away to be creosoted. At present its place for about 146 ft. amidships is taken by yellow pine, to receive the weight of the ships when they are next docked. The docking keels are 16 in. wide amidships across the face of the wood.

Unfortunately the dimensions of existing dry docks do not permit these vessels to be fitted with complete bilge keels. They have them, therefore, only at the ends, about under the turrets, so that they do not extend beyond the line of the amidship section.

Both docking and bilge keels can be seen in the starboard view of the "Kearsarge" and in the port quarter view of the "Kentucky." It happened to be more convenient for pushing the work on these ships to put the military masts in before launching, instead of later, and the masts were accordingly put in. This is the first time that this has been done in this country, and it is in any case an unusual practice. Notwithstanding the great and lofty weight of these steel masts, the vessels were launched with the very ample metacentric height of about 20 ft.

The water line belts extend so far aft that the after ends of them were very likely to be submerged in launching. To make sure of water tightness at these points, the after plate of each belt was put in the ship on the ways. Each of these plates added a weight of approximately 70,000 lbs.

The arrangement of double decked turrets will, when complete, bring great concentration of weights at two parts of each of these ships, but the work on the turrets was not far enough advanced (only the turret track supports being in when launched) to require any particular precaution on this account. Of her machinery equipment, the "Kearsarge" when launched had on board and in place only her main condensers, main circulating pumps and their sea connections, evaporators, main separators, thrust, line, and propeller shafting, double bottom suction pipes, and main and secondary drains. The auxiliary condensers, feed and auxiliary pumps, and parts of forced draft fans were in her, but not in place.

The state of affairs on the "Kentucky" was about the same, and neither ship was launched with her propellers on.

In addition to the parts of her own machinery mentioned each ship had on board, when launched, a donkey boiler mounted on the forecastle, forward of the turret, and a very complete temporary shop of small machine tools.

When launched each ship had on board two bow anchors, weighing approximately 13,200 lbs. each. Altogether the complete launching weights of the ships was estimated at 4,450 tons each.

The following table shows the principal other data of the launch, as calculated by the Government inspectors on duty at the Newport News yard:

Mean draught	10 ft. 9½ in.
Draught forward	8 ft. 7½ in.
Draught aft	12 ft. 11½ in.
Drag	4 ft. 4 in.
Center of gravity aft of midship section	2 ft. 6 in.
Center of gravity above base	12 ft.
Metacentric height (approximate)	20 ft.

Pivoting occurred when the sterns of the ships were about 263 ft. beyond the ends of the ground ways, assuming 7 ft. 7 7-16 in. depth of water over the end of the ways.

Pivot pressure	362 tons
Maximum tipping moment was negative (i. e., tended to raise the sterns)	(—) 3,152 ft. tons

The keels of the "Kentucky" and "Kearsarge" were laid on a declivity of 9-10 in. to the foot and the declivity of the launching ways was 11-16 in. to the foot, with no camber. The management of the Newport News yard holds that a ship is less likely to be strained in launching from perfectly straight than from cambered ways. The ground ways were 28 ft. across, and the breadth of each way was 4 ft. The ground ways were carried out 105 ft. from the bulkhead, or seawall. By this means the total length of run was made 565 ft., and a depth of water at the end of the ways of 26 ft. at mean low tide was provided. It will be seen from this, at Newport News vessels of the size of these battleships could if necessary

be safely launched at ordinary low tide, but in fact the "Kearsarge" and "Kentucky" were launched near high water; the "Kearsarge" on the flood, and the "Kentucky" on the ebb tide.

The usual enterprise of the management was shown by a line of 16 candle-power electric lights all along the inside of the ground ways, making the usually dark and dismal neighborhood of the keel blocks almost as light as the open day outside.

The short length and broad beam of the "Kearsarge" and "Kentucky" make their weight very concentrated—an ordinary merchantman of the same length would probably have about one-half their launching weight—and besides, their lines are rather fine for battleships, requiring about 30 ft. to be left unsupported at each end, so that the pressure per square foot on the sliding surface was not far from 2 1-4 tons.

On this account the management adopted a peculiar form of cradle, which is shown in the illustration on page 7 of the starboard bow cradle of the "Kentucky," the other cradles being similar. No poppets whatever were used. The upright pieces shown were merely toggle-braces to spread the pull of the athwartship ties vertically over the cradle, and the tops of these uprights were cut away to a clearance of about 1 in. from the bottom plating. To spread the heavy pressure as much as possible over the skin of the ship, and to minimize the risk of denting the plates, especially at the moment of pivoting, the cradles were built up solidly of yellow pine packing, of which the top tiers were cut to a snug fit with the skin of the ship. It may be remarked, incidentally, that this form of cradle is cheaper than the usual form with poppets.

The cradles formed one continuous structure with the packing under the waist. Below the wedges the packing all lay fore and aft. Above the wedges there were two fore and aft tiers of packing and then alternate tiers of athwartship and fore and aft packing. Inside and out the packing, above the wedges, was covered by a plank casing secured in place by heavy iron spikes. The fore and aft tiers and the outside casing furnished the only fore and aft ties of the packing and cradles. To spread the pressure over as much of the ships' length as possible the stern cradles were built right up to, and to fit, the propeller bosses, as shown in the illustration of the "Kentucky's" port quarter. There was no support of the stern aft of the cradle.

The only ties to prevent the cradles from splaying out at the sides were three sets of 6 in. manila hawsers of 22 to 30 parts each at each cradle. These hawsers passed from side to side under the keel and secured to the cradles as shown in the illustration of the "Kentucky's" starboard bow cradle. In accordance with present practice these hawsers were not wet before launching.

At the forward ends of the ways heavy oak backing was provided for two 100 ton hydraulic jacks at each side of each ship. Each set of sliding ways ended forward in an oak shoe, or sole-piece, 4 in. by 42 in..

Directly over the ways the double bottoms were well chocked with wood to prevent denting of the plating. Directly over these chocks a row of strong wooden shores was put in between the inner bottom and the protective deck from the stem aft only to the after fire room bulkhead. These shores were braced strongly fore and aft by diagonals extending from the inner bottom to the protective deck. They were also strongly braced horizontally against the midship longitudinal bulkhead and against the outer skin of the ship. The midship longitudinal bulkheads were put up with bolts only to stiffen the ships in launching, as they will have to be taken down in order to install the engines and boilers.

At low tide on the afternoon of March 23 the ways below the stern cradle were greased well down into the water, and the work of removing the rubbish from between the ways was begun.

The work of preparing for the launch was taken up again at 4.00 A. M. on March 24. The time from then until 7.00 A. M. was occupied in clearing up and in organizing the men for the work in hand.

The "Kearsarge" was to be launched first, and the "Kentucky" was to follow as soon as possible. Soon after 7.00 A. M. the "Kentucky's" packing was therefore given a good setting up for about eight minutes. This was done simultaneously all along both sides by gangs of four men each with oak battering rams, there being as many rams along each side as the space would allow to work.

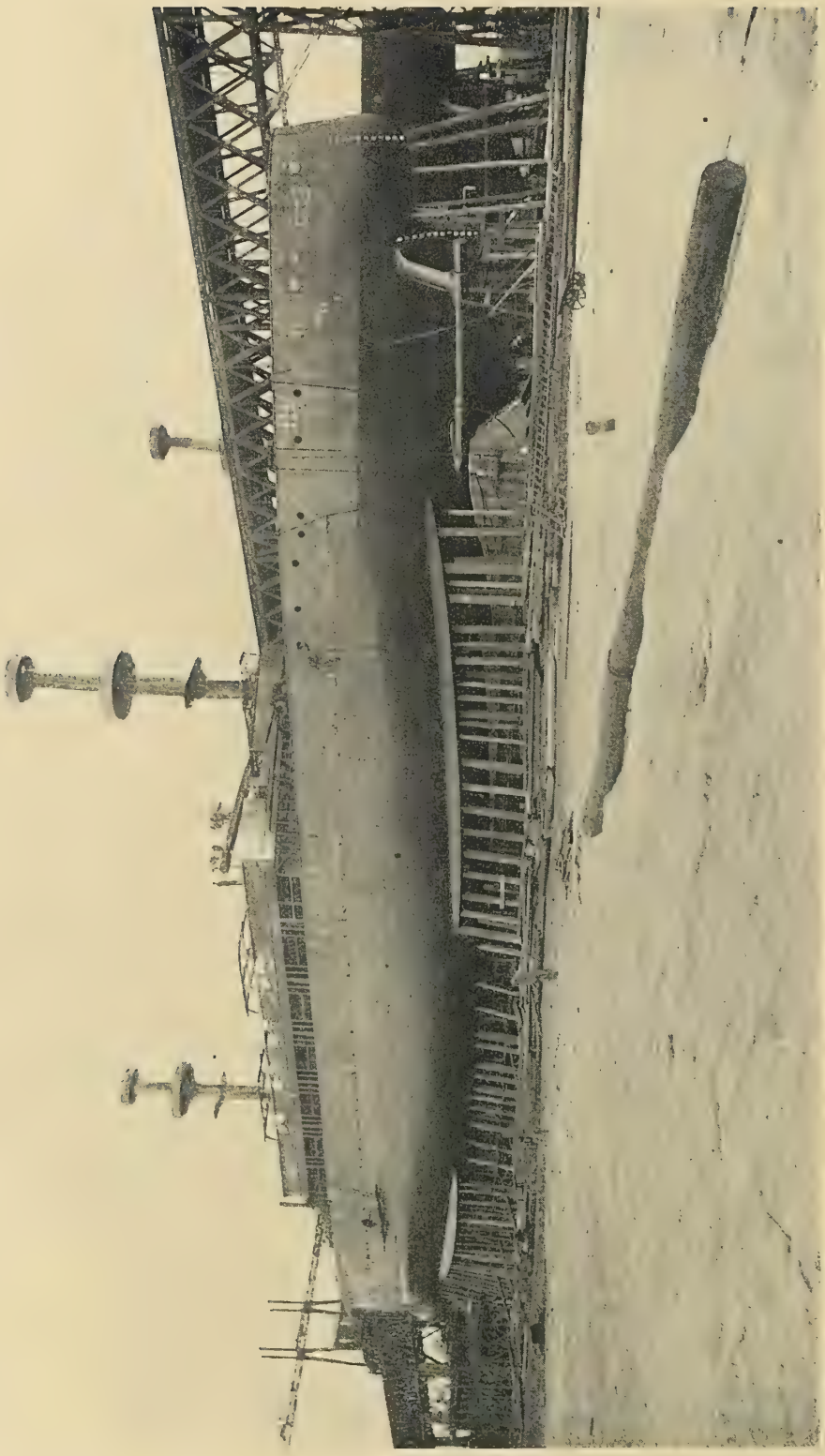
The gangs then moved over to the "Kearsarge" and gave her packing a similar setting up about 7.30 o'clock.

The boards covering the "Kearsarge's" ground ways, inboard of the sliding ways, were then ripped off, and negro boys set to work to scrape off the exposed grease, as it had become full of chips and dirt.

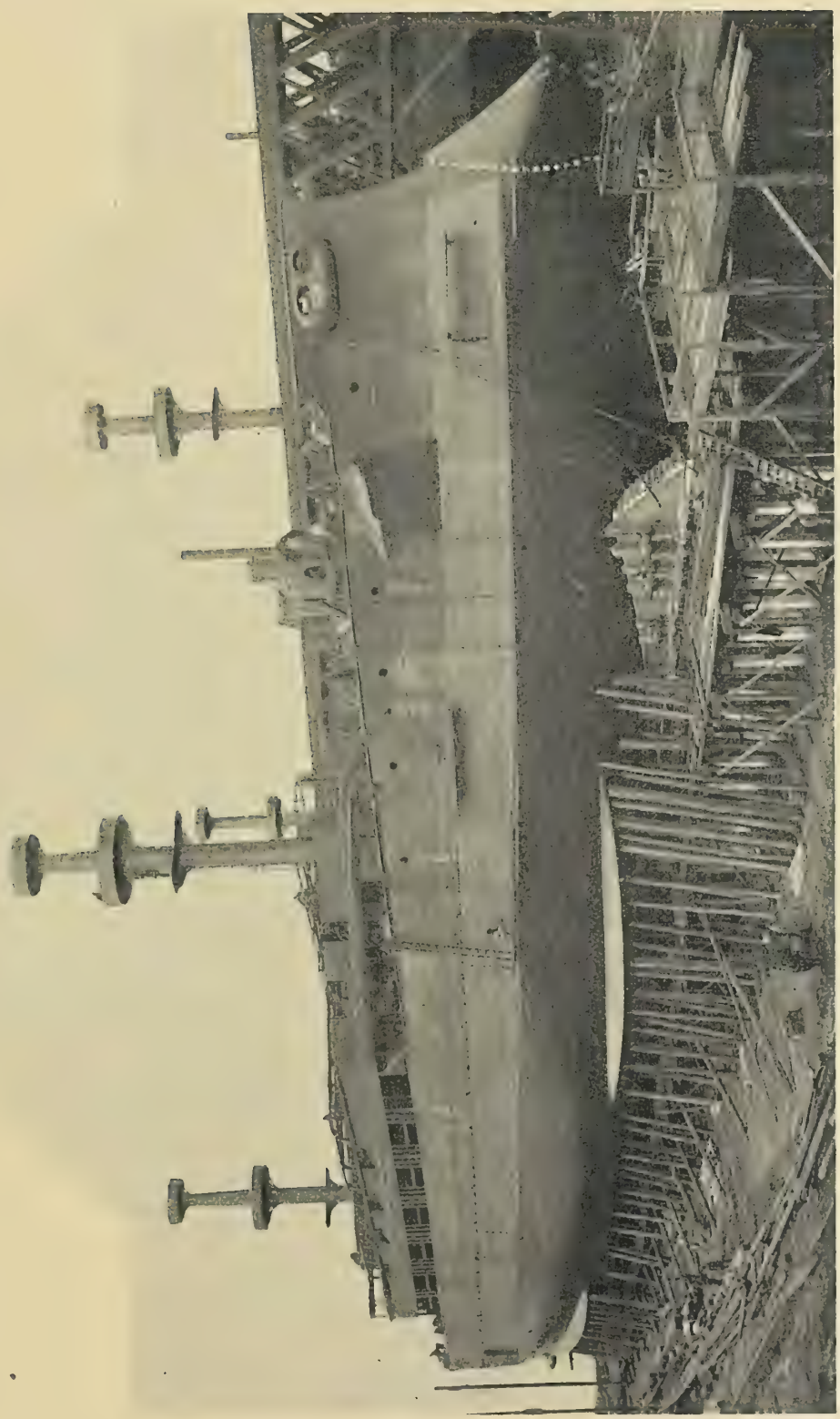
As plenty of time had been allowed in order to be sure of launching on time, there was now a period of waiting and comparative idleness. This brought out strongly the eagerness and enthusiasm of the men, for, at the sound of a hammer, or anything of that sort, they would set to work with their rams all along the ways and pound until word was passed to knock off. At 8.00 A. M. the four 100 ton hydraulic jacks were put in place at the head of the "Kearsarge's" ways.

At 8.30 A. M. a gang started to take down the shores (except trip-shores) between the ways of the "Kearsarge." Throughout the preparations for launching a gang of painters followed and wherever a shore or keel-block was knocked out, a careful examination of the plating was first made for empty rivet holes, dents, and so on, and everything being found correct, the freshly exposed plating was given a coat of paint.

At 8.53 A. M. the shores (except trip-shores),



PORT QUARTER VIEW OF THE U. S. FIRST-CLASS BATTLESHIP KENTUCKY BEFORE LAUNCHING AT THE NEWPORT NEWS SHIPYARD.
(Photographed for Marine Engineering by Rush & Shaw, Newport News, Va.)



STARBOARD BOW VIEW OF THE U. S. FIRST-CLASS BATTLESHIP KEARSARGE BEFORE LAUNCHING AT THE NEWPORT NEWS SHIPYARD.
(Photographed for Marine Engineering by Rush & Shaw, Newport News, Va.)

between the ways, and the 'thwartship wooden struts between the cradle and between the cradles and the hull had all been removed, but a full line of shores was still in along the bilges. The work of splitting out the "Kearsarge" keel blocks was then begun.

At 9.05 A. M. gangs with battering rams began knocking out the shores along the "Kearsarge's" bilges.

At 9.35 A. M. the only keel blocks left were under about one-quarter of the "Kearsarge's" length, clear forward, and more than half the bilge shores were also out. Men were, therefore, then stationed with saws at the shores on both sides to cut her loose if she should start to go.

At 9.54 A. M. the last bilge shore was out.

At 9.57 1-2 A. M. the saw began on the shoes just as the last keel blocks were being split out from under her fore-foot.

The ship started down the ways at 10.01 1-4 o'clock.

As she started, Mrs. Winslow, wife of Lieutenant-Commander Herbert Winslow, U. S. N., the son of the officer who commanded the old "Kearsarge" in her fight with the "Alabama," threw a bottle of wine against the ship's bow and exclaimed, "I christen thee Kearsarge." To prevent a miss the wine bottle had been hung on a line from a pole stuck through the hawse-hole. It hit its mark and broke in foam on the bow.

The launch and christening were entirely successful. The "Kearsarge" sped down the ways with a maximum velocity of 11.49 knots, and was fully waterborne in 57 seconds.

The twenty-one oak trip shores under the keel of the "Kearsarge" aft had been made with their forward upper and after lower corners well rounded off, so that the ship herself knocked them down as she went down the ways.

Owing to the great expanse of water formed by the James river estuary at Newport News, no drags whatever are required in launching there, and none were used on either of these ships.

The "Kearsarge" was taken in tow by several local tugs and made fast to a pier at the southern extremity of the yard.

Work was immediately begun on the "Kentucky." The fact that her packing had been previously set-up, as mentioned above, expedited matters somewhat; otherwise her launch was a repetition of that of the "Kearsarge" and need not be described in detail.

She started at 11.36 o'clock and went down the ways with a maximum velocity of 12.26 knots and she was fully waterborne in 46 seconds. The maximum dips of the sterns of both ships was 17 ft. Miss Catherine Bradley, daughter of Governor William O. Bradley of Kentucky christened the ship with spring water. To remove any ill luck that might follow such a spiritless christening the Kentucky visitors saluted their State's namesake, as she started down the ways, with a fusillade of bottles of good old Bourbon, none of which was observed to miss.

After launching the "Kearsarge" hogged about 1-8 in., and the "Kentucky" about 1-4 in.

No expansion joints or other means of accommodation to change of shape were provided in the upper works of either ship.

The ships are about 58 per cent. completed and can be finished in one year more by working day and night; otherwise they will be ready in from one and a half to two years.

Their armor has all been delivered and is ready to put on. The engines are complete and are set up in the erecting shed. The boilers are also complete and are in the yard ready to put in. The yard's new 140 ton electric jib crane will not be ready for use for two or three months yet, but the work can go ahead with the yard shear legs.

The propelling engines of these two ships are rights and lefts, placed in two water tight compartments and separated by a middle line bulkhead. These engines are of the vertical inverted cylinder direct-acting, triple-expansion type. The collective I. H. P. of the propelling, the air pump and the circulating pump engines will be 10,000, when the main engines are making about 120 revolutions per minute. When in position the H. P. cylinder of each engine will be forward and the L. P. cylinders aft. The framing of the engines consists of wrought steel columns trussed by wrought steel stays. The engine bed plates are cast steel, supported on keelson plates. The condensers are composition and steel. For each propelling engine there will be a double vertical, single-acting air pump, worked by two inverted steam cylinders. The main circulating pumps will be of the centrifugal type, one for each condenser, worked independently. The propellers will be right and left of manganese bronze. Each engine room will have an auxiliary condenser, made of composition, and connected with all the auxiliary machinery. Each of these condensers will have a combined air and circulating pump.

There will be three double ended main and two single ended auxiliary steel boilers of the horizontal return fire-tube type, in each vessel, all constructed for a working pressure of 180 lbs. per square inch. The thickness of shell plates is 1 7-16 in. The boilers will be placed in four water tight compartments. There will be two athwartship fire rooms in each of the main boiler compartments. The mean outside diameter of all boilers is about 15 ft. 6 1-2 in. The two forward double ended boilers are about 19 ft. long, the after double ended boilers are about 21 ft. long, and the single ended boilers about 9 ft. 11 1-2 in. long. There will be two smoke pipes. Forced draught will be on the closed fire room system. The outfit of auxiliaries will be as usual, except that the turrets will be operated by electricity.

The contract price of the ships is $2,500,000 each, without any speed premium.

The work on the battleship Illinois at this yard is well along, and she will probably be launched in from four to six months more.

Emergency Torpedo Boats.

Due to the failure of the Government to secure enough torpedo-boats abroad, the Secretary of the Navy recently directed the Chiefs of the Bureaus of Construction and Repair and of Steam Engineering to report to him the number, displacement and cost of torpedo-boat destroyers and torpedo-boats which should be built by this government. These officials reported in favor of 100 torpedo-boats of about 100 tons displacement and of between 20 and 22 knots speed. The recommendation was limited to these, because it was estimated that they could be completed at least one month sooner than any others. Such boats would be capable of harbor defence only, being too small to go to sea to any extent.

On this account there was considerable opposition, especially from the Assistant Secretary of the Navy, Mr. Roosevelt, to building this type alone. The Secretary, therefore, reported to the President in favor of about thirty destroyers of from 325 to 350 tons displacement and of thirty knots speed, and of about seventy of the smaller boats.

The President has the matter under consideration; and it is expected that he will authorize the expenditure of about $7,000,000 for these boats.

It is estimated that the torpedo-boats can be completed within ninety days, and the destroyers within four or five months.

The department is thoroughly informed as to what the shipbuilders of the country can and will do in the matter; and the Bureaus of Steam Engineering and Construction and Repair have already prepared contracts for the hulls and machinery, so that the contracts can be let as soon as the President's decision is formally announced.

Naval Appropriation Bill.

The Naval Appropriation bill was reported to the Senate on April 12 by the Appropriations Committee. The bill had already passed the House; but the Senate Committee increased the aggregate appropriation by $8,263,500, making the total $46,277,558.

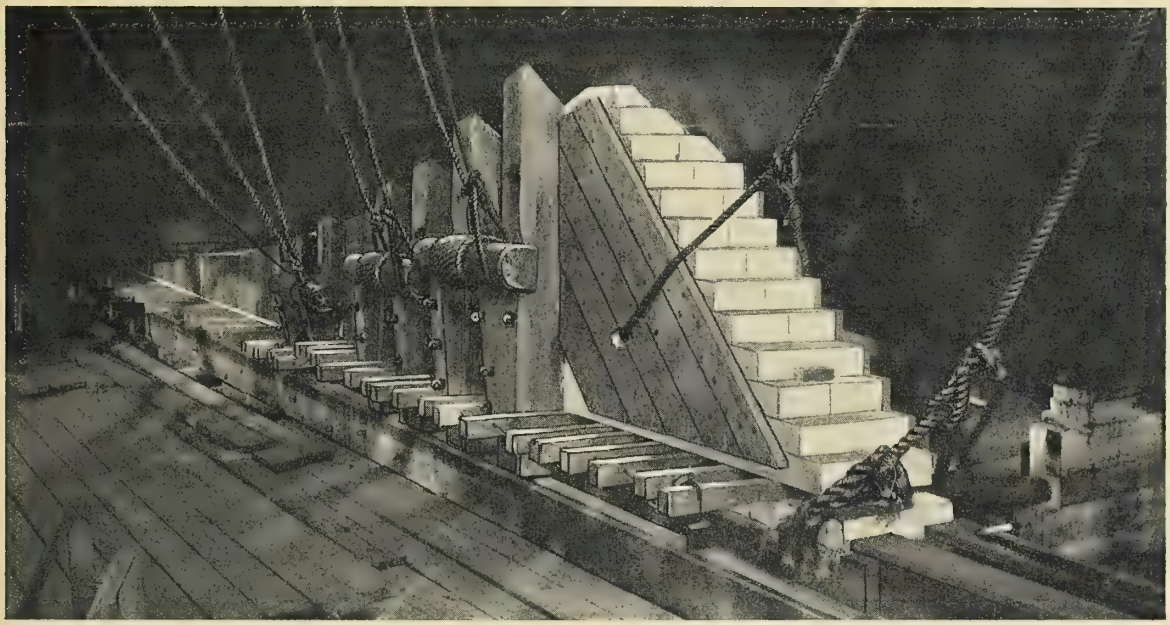
The principal provisions of the bill as reported to the Senate are as follows:

The President is authorized to have constructed by contract three sea-going coast-line battleships, designed to carry the heaviest armor and the most powerful ordnance upon a displacement of about 11,000 tons, to have the highest speed practicable for vessels of their class, and to cost, exclusive of armor and armament, not exceeding $3,000,000 each, one of said battleships to be named the Maine; four harbor defense vessels of the monitor type, to cost, exclusive of armament, not more than $1,250,000 each, and to have one or two turrets each; sixteen torpedo-boat destroyers of 400 tons and twelve torpedo-boats of 150 tons displacement, to have the highest practicable speed, and to cost, exclusive of armament, not exceeding $6,900,000; one gunboat to replace the U. S. S. Michigan, stationed on the Great Lakes, to be built on the Great Lakes or connecting waters, and to cost, exclusive of armament, not more than $260,000.

The four harbor defense vessels and four torpedo-boat destroyers were added to the House bill by the Senate Committee.

One of the harbor defense vessels is to be built on the Pacific coast. Not more than two of the battleships, two of the monitors or five of the torpedo-boat destroyers are to be built at any one yard.

A sum of $7,162,000 is appropriated for the



CONSTRUCTION OF THE LAUNCHING CRADLES FOR BATTLESHIPS KEARSARGE AND KENTUCKY.

armor and armament of the vessels authorized, and $375,000 for their equipment.

To the paragraph of the House bill authorizing four timber dry docks, one each at Portsmouth, N. H., Boston, League Island, Pa., and Mare Island, Cal., a provision is added allowing the Secretary of the Navy, in his discretion, to have one of them built of granite or of concrete faced with granite, in which case the limit of cost is raised by $200,000.

Improvements to the naval station at Port Royal, S. C., are provided for in an appropriation of $330,000, of which the principal items are $100,000 for dredging a channel to the station; $75,000 for a new wharf, adjoining the dry dock, and $50,000 for a machine plant capable of repairing boilers and engines of United States naval vessels.

The enlistment of 2,000 additional men for the navy is authorized, and the House provision for enlistment is stricken out and the following substituted:

"And whenever, within the next twelve months, an exigency may exist which, in the judgment of the President, renders their services necessary, the Secretary of the Navy is hereby authorized to appoint from civil life and commission such acting officers of the line and staff, not above the rank or relative rank of lieutenant, as may be requisite; provided, that such officers shall serve only during the continuance of the exigency under which their services were required; and provided further, that such officers so appointed shall be assigned to duty with rank and pay of the grades established by existing laws."

$500,000 is appropriated for improvements to the naval academy, and contracts for the same are authorized to the amount of nearly $1,000,000, of which the following are the most important: New armory, cost not to exceed $300,000; new boathouse, cost not to exceed $300,000; new power-house, cost not to exceed $100,000; four double houses for officers' quarters, cost not to exceed $60,000; grading, electric light wiring, renovating old buildings and preparing plans, not to exceed $90,000.

To repair the damage done to the navy yard, Mare Island, Cal., by the recent earthquake, $350,000 is appropriated, and $50,000 is appropriated toward a naval training station for apprentices on Yerba Buena Island, San Francisco Bay, Cal., which is to cost $100,000.

The Secretary of the Navy is authorized to have the Yantic, the training ship of the Michigan naval militia, repaired out of the appropriation for that body. For a steam water boat for the Norfolk Navy Yard, $6,000 is appropriated.

The royalty for steel face hardening is limited to one-half cent per pound.

The bill provides for the transfer of the hydrographic office, Navy Department, from the Bureau of Navigation to the Bureau of Equipment.

The smokeless powder clause was stricken out.

REGULATIONS FOR THE APPOINTMENT OF NAVAL ENGINEER OFFICERS FROM CIVIL LIFE.

The most serious need of the Navy at the present moment is a sufficiency of skilled marine engineers. This has at last been recognized by Congress, and in the Naval Appropriation bill the following clause was inserted:

And whenever, within the next twelve months, an exigency may exist which, in the judgment of the President, renders their services necessary, the Secretary of the Navy is hereby authorized to appoint from civil life and commission such active officers of the line and staff, not above the rank or relative rank of lieutenant and warrant machinists, as may be requisite: Provided, that such officers shall serve only during the continuance of the exigency under which their services are required: and provided further, that such officers so appointed shall be assigned to duty with rank and pay of the grades established by existing law.

While applicants for any seagoing corps of the service (line, engineer, medical and pay) may be appointed under this proposed law, the most urgent need, as stated, is for engineer officers, and plans have been made to form a volunteer corps of engineer officers, with acting appointments.

Anticipating the passage of this provision of law, the Navy Department has issued instructions dividing applicants into four classes:

First.—Ex-graduates of the Naval Academy.

Second.—Ex-naval cadets, not graduates.

Third.—Officers of merchant marine and naval militia.

Fourth.—All others.

(1.) When an applicant is selected for appointment, he shall be ordered by the detail officer to appear for such examination as may be requisite.

(2.) Line and engineer officers shall pass physical and professional examinations and file recommendations as to sea experience.

(3.) Appointees to be selected as the Secretary may direct.

All merchant ships recently purchased by the government will be manned in the machinery department by volunteer engineers. Indeed, so urgent was the necessity that five engineers of the American liner St. Paul, after purchase by the government, were offered commissions immediately and without examination, before any authority of law had been passed.

The proposed commissioned grades to be established in the Engineer Corps are as follows:

Chief Engineer, with the relative rank of Lieutenant.

Passed Assistant Engineer, with the relative rank of Lieutenant.

Passed Assistant Engineer, with the relative rank of Lieutenant of the Junior Grade.

Assistant Engineer, with the relative rank of Ensign.

Candidates for appointment as volunteer engineer officers should address their applications to the Chief of the Bureau of Steam Engineering, Washington, D. C. Permission to appear for examination will be given those who are suited for the service. The professional examination

will be conducted before a board of regular engineer officers, convened at the Postoffice Building, Philadelphia, Pa., for the purpose. The physical examination will be before a board of medical officers in the same city.

We here reproduce the general form granting permission to applicants to appear for examination for a commissioned officer for either line or staff; the blank spaces are of course to be filled in at the Bureau of Navigation according to the position applied for:

Address Bureau of Navigation, Navy Department, and refer to No.....

WASHINGTON, D. C., ...

Sir:

A Naval Examining Board and a Medical Board are now in session at ..... for the examination of candidates for admission into the United States Navy as Acting .....

You have permission, if of full age and a citizen of the United States, to present yourself to the Medical Board for examination as to your physical qualifications for the naval service.

If found to be physically qualified, you are authorized to report to the President of the Naval Examining Board for examination as to your professional and moral qualifications, and if in all respects qualified, an appointment as an Acting ..... will be given you when your services shall be required.

You will present this letter to the Boards.

Please keep this Bureau informed of your address.

Respectfully,

.....

Chief of Bureau.

It will thus be seen that no way is yet open for the appointment of any engineers from civil life to permanent commissioned rank in the Navy. There is, however, an opportunity for marine engineers, mechanics and subordinates who wish to enlist in the Navy to secure appointments as "machinists," of various grades or as mechanics or as firemen. Under ordinary circumstances enlistments are for three years, but in the present emergency enlistments are made for one year, with the understanding that the men may withdraw or be discharged inside of that time should their services be no longer required. Usually also an engineer cannot enlist as a "chief machinist," but must work up from the lower ratings, but now if in possession of first-class marine papers he will be eligible for the rank of "chief machinist."

All applicants for enlistment in the naval service must be of robust frame, intelligent, of perfectly sound and healthy constitution and free from serious physical defects. Following are the ratings:

Chief machinist.....	pay $70 per month
Machinist:	
1st Class	" 55 " "
2d Class	" 40 " "

A candidate for enlistment must know the names and uses of the various parts of a marine engine and boilers, and must be able to perform work with various tools in a machine shop, including bench work. He must be able to write legibly and must understand arithmetic; and at the date of first enlistment must not be less than twenty-one nor more than thirty-five years of age.

Machinists who have had no experience at sea with marine engines will be enlisted as "machinists, second class." Those who have had experience at sea with marine engines for one year may be enlisted as "machinists, first class."

No person will be enlisted as chief machinist unless he holds a permanent appointment as such.

The examination of candidates for enlistment as machinists, regarding their knowledge of engines and of boilers, must be made in the engine rooms of ships; and regarding their knowledge of machine work, in the workshops of navy yards.

Chief machinists will have charge of engine-room watches. Machinists, first class, will, if qualified, be given charge of an engine-room watch when there are not a sufficient number of chief machinists on board to perform this duty.

Machinists, second class, will be assigned to duty as water tenders and oilers. All machinists will perform such other duties as may be assigned them.

Boilermaker.—Limit for age, 21 to 35 years. Must thoroughly understand his trade. Pay, $60 per month.

Blacksmith.—Limit for age, 21 to 35 years. Must be able to pass a rigid examination as to physical and mechanical qualifications. Pay, $50 per month.

Coppersmith.—Limit for age, 21 to 35 years. Must thoroughly understand his trade. Pay, $50 per month.

Plumber and Fitter.—Limit for age, 21 to 35 years. Must be thoroughly qualified to fill the rating. Pay, $45 per month.

Fireman, First Class.—Age, 21 to 35 years. Must have had experience as fireman on a steamer and must know about marine engines and boilers and their attachments. He must thoroughly understand the management of the fires, how to regulate and use the different valves on the boilers and the different pumps. He should know how to put on a soft patch, and be able to wrap pipes to stop a leak. He must know how to pack the stuffing boxes around the engines and how to grind in valves, etc. He must also understand about oiling the working parts of an engine. The pay is $35 per month.

Firemen, first class, are eligible for the rating of water tender, $40, and oiler, $37 per month.

Fireman, Second Class.—Limit for age, 21 to 35 years. Must have had experience as a fireman, preferably on board a steamer, and must understand the working of fires. He should know something of the engines, the different pumps, the boilers and the attachments to the boilers, and their uses. The pay is $30 per month.

Coal Passer.—Limit for age, 21 to 35. Candidates should preferably have had some experience in firing either on shore or in steamer. The pay is $22 per month.

Men of all ratings are entitled to one ration or three meals per day. Applicants must present themselves on board receiving ships at the navy yards for examination, previous to enlistment, at their own expense. These are located at Boston,

Mass.; Navy Yard, New York; League Island, Philadelphia; Norfolk, Va., and Mare Island, San Francisco, Cal. No money is allowed for traveling expenses. Preference will be given to applicants who can read, write and are American citizens by birth or naturalization, or who have declared their intentions to become American citizens. No person can be enlisted who does not understand and speak the English language.

As this issue goes to press, dispatches from Washington say the Secretary of the Navy will be authorized to appoint an unlimited number of warrant machinists, to act as engineers, at $1,200 per annum.

STRENGTH OF THE SPANISH NAVY BROUGHT DOWN TO DATE.

On account of the number of inquiries we have received relative to the strength of the Spanish Navy we have prepared a series of reference tables which are printed herewith. It is hardly necessary to say that unless such tables are intelligently used they are more likely to produce wrong impressions than impart accurate information. The ships have been grouped in various classes, permitting some comparison with the strength of the several classes of our own Navy, reference tables of which were published in our March issue. The refinements of armor and armament have not been gone into, both for the reasons that they would complicate the tables and that they would be of little real value to any but an ordnance expert. The date of build of a vessel, which is given in each case, affords a line upon her equipment in these respects, although, so far as armament is concerned, old vessels might be equipped with very modern guns. Armor varies, not only in thickness, but in the quality of resisting penetration, so that a comparatively thin armor plate of modern make would be much more effective than a very much heavier plate of old-time armor plate. The same rule applies to weapons, the improvements in main and secondary and machine gun batteries having been very considerable since the introduction of the ironclad in naval construction. Then speed is a very important factor in determining the efficiency of a navy, or fleet, intended for deep water operations, for speed, of course, means manoeuvring capacity. It will be noticed that in point of numbers the Spanish Navy is strong. As to its quality, there are about fifty vessels on the active list ranging in displacement from 500 tons upward to 9,900 tons, which might be considered as formidable. Then the torpedo fleet, including the splendid destroyers recently built on the Clyde for Spain, would be next in destructive capabilitiy. For the rest the Navy is composed largely of small gunboats, mostly of light draught, for use in river or patrol work in shallow waters. The only out-and-out battleship possessed by Spain is the "Pelayo," a heavily armored and armed vessel of rather antiquated type, having been built in France in 1887, and lately undergone extensive alterations there. There are also nine armor plated cruisers and five cruisers with protective decks. The former include six fast ships, each carrying guns as heavy as 11 in. and a considerable thickness of armor, and possessing high speed. This type was represented by the warship Vizcaya which lay in New York harbor not long ago. Many of the ships are antiquated, especially the smaller gunboats. The Spanish Navy is not all a home product, but contains a large number of ships built in Britain, France and Italy. The large guns are mostly of the Hontoria pattern, while there is a fair proportion of Armstrong and Krupp weapons in the batteries of the fleets. The machine guns include the automatic Maxim type. It should not be forgotten that the tables represent the Spanish Navy on paper, and a liberal allowance might be made in practice for mishaps, unreadiness for sea, ships undergoing repair, and other factors which would affect the strength of the Navy.

STEEL AND IRON ARMORED SHIPS.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
ARMOR ABOUT 12 IN.—	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
AlmiranteOquendo, '91	340	60	21 6	6,800	20	13,000
Cardenal Cisneros, '96	347 10	61	22	7,000	20	15,000
Infanta Maria Teresa, 90	340	65	21 6	7,000	20.20	13,500
Pelayo, '87	330	66	24 11	9,900	16	9,000
Princesa de Asturias, '96	347 10	61	21 10	7,000	20	15,000
Vizcaya, '91	340	65	21 6	7,000	20.5	13,000
ARMOR 2 IN. TO 5 IN.—						
Emperador Carlos V., '95	380	67	25	9,000	20	18,000
Pug-cerda (monitor), '74	128	29 6	6 6	550	8	330
Numancia, '63 (reconstructed '97)	314	54	25	7,300	12	....
Vitoria, '65 (reconstructed '97; training ship).	318	55 10	25 2	7,100	12	4,500
Cristobal Colon, '96	328	59 9	23 3	6,800	19.35	10,670

STEEL PROTECTED CRUISERS.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft in.	Tons.	Knots.	
Alfonso XIII, '91	318 6	50 6	20	5,000	20	11,000
Isla de Cuba, '87	185	30	11 6	1,030	16	2,200
Isla de Luzon, '87	185	30	11 6	1,030	16	2,200
Lepanto, '92	318 6	50 6	20	4,800	20	12,000
Marques de la Ensenada, '90	185	30	11 6	1,030	16	2,200

UNARMORED STEEL CRUISERS—NOW USED AS TRANSPORTS.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	feet	Tons.	Knots.	
Alfonso XII, '87	278 10	42 8	16	3,090	17.5	4,800
Reina Christina, '86	282	42 7	16	3,400	17.5	4,750
Reina Mercedes, '87	279	42 7	16	3,200	17.5	4,700

Unarmored Iron Cruisers

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	feet	feet	ft. in.	Tons.	Knots.	
Conde de Venadito, '88	210	32	12 6	1,140	13.5	1,550
Don Antonio de Ulloa, '87	210	32	12 6	1,140	13.5	1,550
Don Juan de Austria, '87	210	32	12 6	1,140	13.5	1,550
Infanta Isabel, '85	210	32	12 6	1,140	13.5	1,550
Isabel II, '86	210	32	12 6	1,140	13.5	1,550
Jorge Juan, '76	203	30	12	935	13	1,100
Velasco, '81	210	31	12 6	1,140	14	1,500

Unarmored Steel Gunboats.

Name and Date	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Alvarado, '95	110	15 6	5 4	100	10	....
Diego Velasquez, '95	135	19	6 6	200	12	....
Hernan Cortes, '95	155	21 6	6 6	300	14.5	....
Macmahon, '87	90 6	13 5	4 3	115	10	150
Pizarro, '95	155	21 6	6 6	300	14.5	....
Ponce de Leon	135	19	6 6	200	12	....
Sandoval, '95	110	15 6	5 4	100	10	....
Vasco Nunez de Balboa, '95	155	21 6	6 6	300	14.5	....
Six gunboats, '95	114 9	16 5	8 2	135	10	220
Six gunboats, '95	75	12	6 3	40	11	....
Two river boats, '96	94	25	3 4	90	10	175
Six gunboats, '87	114	17 6	6	137	10	....
Three gunboats, '93	75 5	13 2	3 10	45	9	....
Three gunboats, '87	78 9	12 10	Light	48	13	....
Eight gunboats, '95	77	11 2	Light	43	11	....
Two gunboats, '93	85	13	5 10	71	12	270

Unarmored Iron Gunboats.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
El Cano, '85	158	26	8 6	525	11	600
Fernando el Catolico (torpedo school ship), '75	157 5	25 7	8 5	500	10	550
General Concha, '83	157 5	25 7	8 6	520	11	600
General Lezo, '85	158	26	8 6	525	11	600
Magellanes, '85	157 5	25 7	8 6	520	11	600
Marques del Duero, '75	157 5	25 7	8 6	500	10	550
Argos (survey vessel), '80	155 4	22 2	12 6	508	7	300
Alsedo, '82	115	22	6 3	216	9	250
Eulalia, '82	115	22	6 3	216	9	250
Pilar, '81	115	22	6 3	216	9	250
Salamandra, '75	111	21	5 6	190	8	210
Leyte, '75	100	....	....	150	10	120
Calamianes, '86	91 9	16 5	6 6	150	8	120
Mariveles, '86	98 5	16 5	6 6	142	10	120
Mindoro, '85	98 5	16 5	6 6	142	10	120
Two gunboats, '95	78	....	....	65	11	20
Two gunboats, '95	60	....	....	30	9	....
Delgado Parejo, '95	97 6	....	....	85	12	....
Urdanete, '84	60	9 9	3 10	28	7	40
Vasco, '83	60	9 9	3 10	28	7	40
Tarifa, '79	60	13 2	4 3	46	7	65
Otalora, '81	82	13	5	37	8	40
Guardoqui, '84	69	13	5 3	41	8	40
Esperanza, '95	58 6	13	4 6	23	10	....

Composite Gunboats.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Quiros, '95	145 4	22 10	10 8	348	12	500
Villalobos, '96	145 4	22 10	10 8	348	12	500

Steel Torpedo Gunboats.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in	ft. in.	ft. in.	Tons.	Knots	
Don Alvaro de Bazan, '97	235	26 2	10	830	19	3,500
Dona Maria de Molina, '96	235	26 2	10	830	19	3,500
Destructor, '87	192 6	25	7	420	22	3,800
Filipinas, '92	232 10	27	8 6	750	20	4,600
Galicia, '91	190 3	23	10 4	570	19	2,600
Marques de la Victoria, '97	235	26 2	10	830	19	3,500
Marques de Molins, '91	190 3	23	10 4	570	19	2,000
Martin Alonzo Pinzon, '92	190 3	23	10 4	570	19	2,600
Nueva Espana, '89	190	23	11 9	630	18	2,600
Papido, '91	190	23	10 4	570	18	2,600
Temerario, '89	190 3	22 10	10 4	570	20	2,600
Vincente Yanez Pinzon, '89	190 3	22 10	10 4	570	19.5	2,600

Steel Torpedo-Boat Destroyers.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	feet	ft. in.	ft. in.	Tons.	Knots.	
Audaz, '97	225	22 6	5 9	400	30	7,500
Furor, '96	220	22	5 6	370	28	6 000
Osado, '97	225	22 6	5 9	400	30	7,500
Pluton, '97	225	22 6	5 9	400	30	7,500
Proserpina, '97	225	22 6	5 9	400	30	7,500
Terror, '96	220	22	5 6	370	28	6,000

Steel Torpedo Boats.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Twelve 1st-class, '83 to '87	105 to 147	10.9 to 14.5	3.3 to 6	57 to 108	19 to 26	660 to 1,000
Three 2d-class, '78 to '83	43.5 to 84.5	9.7 to 10.7	2.3 to 4.6	25 to 33	8 to 19	175 to 450
One submarine, '89	70	8 5	....	87	10	60

Cruisers with Wooden Hulls.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	feet	feet	feet	Tons.	Knots.	
Aragon, '79	246	46	21	3,342	14	4,400
Castilla, '81	246	46	21	3,342	14	4,400
Navarra (cadet train'g ship), '81	246	46	21	3,342	14	4,400

Wooden Steam Vessels Carrying Guns.

Name and Date.	Length	Beam.	Draft.	Displacement.	Speed.	I. H. P.
	feet	feet	ft. in.	Tons.	Knots.	
Albay, '86	100	....	....	250	9	....
Cocodrillo, '75	111	21	5 10	250	6	....
Cuba Espanola, '70	115	22	4 10	225	9	130
Indio, '69	108	22	6 3	200	10	....
Pelicano, '75	111	21	6 10	345	6	....
Prosperidad	140	23	9 6	415	6	130
Prueba, '77	82	15	7 10	122	8	108
Five gunboats, '69	108	22	5 7	179	7	138
Seven small vessels, rang'g from 40 to 150 tons	....	....	....	....	....	....

MISCELLANEOUS SPECIAL SERVICE VESSELS, MOSTLY OBSOLETE.

Name and Date.	Material.	Service.	Displacement.	Speed.	Propulsion
			Tons.	Knots.	
Almansa, '64	Wood	Train'g ship	4,000	7	Screw
Asturias, '57	"	Cadet scho'l	1,500	7	"
Blanca, '59	"	Train'g ship	2,500	7	"
Carmen, '61	"	"	3,100	8	"
Gerona, '64	"	Gun'y sch'l	4 000	9	"
Lealtad, '60	"	Train'g ship	3,000	9	"
Nautilus, '68	Composite	Cadet training ship	800	..	Sail
Tornado, '66	"	Torpedo sc'l	2,000	9	Screw
Urania, '95	Steel	Dispatch b't	670	..	"
Ville de Bilbao, '47	Wood	Train'g ship	1,200	..	Sail
Zaragoza, '67	Wood (armored)	Torpedo school	5,600	8	Screw
Six tugs	Wood and iron	....	....	..	Scr'w & paddle

AUXILIARY VESSELS—ARMED TRANSPORTS AND CRUISERS.

Name and Date.	Length	Beam.	Depth.	Tonnage.	Speed.	N.H.P.
	ft. in.	ft. in.	ft. in.	Gross.	Knots.	
Alfonso XII, '88	438 5	48 8	24 9	5,063	15	700
Alfonso XIII, '88	400	48	....	4,381	16	....
Buenos Aires, '87	410 6	48 2	....	5,195	14	....
Cataluna, '83	384 2	42 2	27 5	3,488	14	750
City of Richmond, '73 (formerly Inman Liner)	440	43 5	34 1	4,989	....	700
Ciudad de Cadiz, '78	363 6	38 2	24 2	3,084	13.5	700
Cuidad Condal, '72	316 5	38 2	28 3	2,596	....	....
Isla de Luzon, '82	381 9	44 2	....	4,252	13	....
Isla de Mindanao, 81	376 5	42 3	26 2	4,195	13.5	....
Isla de Panay, '82	362 4	43 2	....	3,636	13.5	....
Leon XIII, '90	410 4	46 1	....	4,687	15	....
Magallanes, '81 (formerly Guion Liner Alaska)	500	50	38	6,932	18	I. H. P. 10,500
Monte Video, '89	410 5	48 2	....	5,096	14.5	....
P. de Satrustegui, 90	410	46 1	....	4,638	15	....
Five merchant steamers	....	....	....	500 to 1,500	7 to 10	....

WARSHIPS NOW UNDER CONSTRUCTION.

Name.	Length	Beam.	Draft.	Displacement.	Speed.	I.H.P.
	ft. in.	ft. in.	ft. in.	Tons.	Knots.	
Armored cruiser ..	....	....	...	11,000	19	....
Armored cruiser ..	....	....	....	10,000	21	....
Cataluna (armored cruiser)	347 10	61	22	7,000	20	15,000
Pedro d'Aragon (armored cruiser)	328	59 8	24	6,850	20	13,000
Reina Regente (protected cruiser)	337 10	52 6	19 9	5,400	20	....
Rio de la Plata (protected cruiser)	246	35 5	14 3	1,775	20	7,000
Unarmored cruiser	....	....	....	1,800	20	....
Veloz (torpedo gunboat)	213	27	8 6	750	20	4,500
Cadet training ship	....	....	....	3,000	....	....

New Revenue Cutter for the Yukon.

The Treasury Department has received at the headquarters of the Revenue Cutter Service in Washington, the drawings of the hull of a new revenue cutter for which an appropriation has been made by Congress. She was designed on the west coast, especially for service on the Yukon River; the hull by Captain C. S. Hooper, United States Revenue Cutter Service; and the engines by Chief Engineer James A. Doyle, United States Revenue Cutter Service.

The vessel is to be a flat bottomed stern-wheel steamer, and is to be built of wood. She is to be 160 ft. long on the load water line, and 174 ft. long over all, not including the wheel. The wheel is to be 22 ft. dia., and the dip 18 in. The paddles are to be fixed. The boat's extreme beam is to be 36 ft., and the draught, 2 ft. She is to have a deck house extending 146 ft. forward from the stern. There are to be three decks, main, berth, and hurricane. From the main to the berth deck and from the berth to the hurricane deck, in the waist, there will be 7 ft. 'tween decks. The hurricane deck extends forward only 142 ft. from the stern. There will be a balanced rudder, which will probably be of the usual river type, with 3 blades.

The boilers are to sit on the main deck under the extreme forward end of the deck house, to balance the weight of the engines, which are to be located as far aft as possible. The plans call for two locomotive marine boilers, to carry 160 lbs. steam pressure, each boiler to be 64 inches dia. and 24 ft. long over the smoke boxes. They are to be fitted with steam and mud drums, and with grates to burn either coal or wood. Each boiler is to have 29 1-4 ft. of grate surface and 1,400 sq. ft. of heating surface. The boilers are to be placed side by side, with their axes fore and aft. There is to be one smokestack, 30 ft. high from the grates.

The designs include two tandem compound engines; Each H. P. cylinder 16 in. dia.; and each L. P. cylinder 28 in., with 84 in. stroke. The engines are to be on the main deck. There is to be an engineers' office, 12 ft. by 8 ft. in the forward end of the engine room, amidships.

The auxiliaries are one steam capstan, one steam steering engine, and a complete electric light plant, including a searchlight.

The armament will consist of two 1-pounder Hotckiss guns, one on each side of the main deck just forward of the deck house.

There will be a pilot house on the hurricane deck, at its forward end, with the steam steering engine on the berth deck directly under the pilot house. The remaining space on the berth deck forward of the smokestack will be occupied by the pantries, galleys, lamp rooms, and carpenter shop. On the berth deck, just abaft the smokestack there will be the ward room, officers' state rooms, armory, and medicine locker. Next aft will be the captain's cabin, and then the crew's quarters, which will be a space 46 ft. long, extending from the after bulkhead of the cabin to 20 ft. forward of the stern. The remaining space at the after end of the berth deck will be used for water closets and bath rooms.

The complement of the vessel will be three officers, of whom one will be an engineer, and thirty men. It is reported at the Treasury Department in Washington that there have already been about thirty applications by officers of the Revenue Cutter Service for duty on this boat.

Congress appropriated $40,000 to pay for this vessel. Wm. H. Birch & Co., of San Francisco,

offered to build and equip her for $32,650, and secured the contract.

Shipbuilding Returns for the U. S.

The following is the official list of sailing and steam vessels built in the United States and recorded by the Bureau of Navigation, Treasury Department, during the quarter ending March 31, 1898:

A summary shows the total number of sail to be forty-seven, of 4,177 gross tons, and of steam

Where built.	Wood.				Steel.			
	Sail.		Steam.		Sail.		Steam.	
	No.	Gross.	No.	Gross.	No.	Gross.	No.	Gross.
Atlantic & Gulf.	39	3,828	27	1,993	..	....	6	2,400
Pacific.....	8	349	10	1,881	..	....	..	....
Great Lakes....	..	....	1	73	..	....	..	....
Western Rivers.	..	....	20	2,440	..	....	..	....
								....
Total....	47	4,177	58	6,387	..	....	6	2,400

sixty-four, of 8,787 gross tons, or a grand total of 111 vessels of 12,964 gross tons. The grand total for the quarter ending December 31, 1897, was 185 vessels of 18,389 gross tons.

U. S. S. Michigan on the Great Lakes.

An appropriation of $260,000 in the Navy estimates for a war vessel to replace the "Michigan" on the Great Lakes calls attention to that famous old ship. She is a side-wheel iron vessel, the oldest in the Navy, and undoubtedly one of the oldest iron steam vessels in active service in any waters. She is classed as a special service vessel and is armed with four 30-pounder breech loading rifles, three 3-in. breech loading howitzers, and two Gatling guns. Her dimensions are: Length, 167 ft. 6 in.; beam, 27 ft. 1 in.; depth, 12 ft. 9 in., and displacement 685 tons. The hull plans were drawn about the year 1841 by Naval Constructor Samuel Hartt, and those for the machinery by C. W. Copeland. Material for the hull was rolled at Pittsburg and transported to Erie, Pa., where she was launched in 1843, and in the following year went on her first cruise. The original engines, which are still in the boat, are of the inclined type, with cylinders 36 in. dia. by 96 in. stroke. The wheels, as designed, were 21 ft. 10 in. dia. and 7 ft. 6 in. wide, with a dip of 3 ft. The original boilers were of the flue type with 1,620 ft. of heating surface, and furnishing steam at 15 lbs. pressure. The coal consumption was about 1,400 lbs. an hour and the rate of evaporation about 5 pounds of water per pound of coal. These boilers were taken out several years ago and more efficient generators substituted. The bunker capacity is about 120 tons, anthracite coal being used. The speed of the vessel is only 10 knots. For all practical naval purposes she is, of course, out of date, but nevertheless as an example of what American shipbuilders could do, half a century ago, she is a notable exhibit.

U. S. IRON GUNBOAT MICHIGAN ON THE GREAT LAKES.

LIST OF VESSELS RECENTLY PURCHASED OR REQUISITIONED BY THE NAVY.

On account of the widespread interest taken in the auxiliary vessels recently acquired by the Navy we herewith publish a reference table. This gives the new name of each vessel, with her general characteristics and notes of armament. It is not possible, of course, to make this complete, or as exact in details as would be desirable. This is chiefly because the Government, in the present emergency, has given power to various officers to purchase vessels upon their own judgment. Owing also to the scarcity of naval officers for shore duty the Navy Department has dispensed, as far as possible, with detailed reports from shore stations, and so in many cases there is little information available about vessels purchased, except their names and class. Even as we go to press, too late to tabulate, the purchase of additional vessels is reported. This table, however, is based on official information from the Department, and filled out from other sources.

(See pages 14 and 15.)

WARSHIPS AND AUXILIARY VESSELS RECENTLY ACQUIRED BY THE UNITED STATES NAVY BY PURCHASE, CHARTER OR TRANSFER.

Old Name.	Old Class.	Length. Ft.	Length. In.	Breadth. Ft.	Breadth. In.	Depth. Ft.	Depth. In.	Draught. Ft.	Draught. In.	Displacement. Tons.	Propulsion.	Horse Power.	Speed. Knots.	Rig.	Where Built
Abrouill	Protect'd cruiser	330		43	9	25		16	10	3,450	Twin screws	7,500	20	2 military masts	Sir W. G. Armstrong, Whitworth & Co., Elswick, Newcastle-on-Tyne
Ægusa*	Steel yacht	264		31	6	20	6	.....		1,230 T. Y. M.	Single screw	2,500	16.25	.....	Scott & Co., Greenock
Alice	Steam lighter	.....		.....		.....		.....		260.02 gross	.....	....	....	.....	Rockyhill, Conn
Alicia	Yacht	160		22		13		11		425	Single screw	....	18	Schooner	Harlan & Hollingsworth
Almy	"	155	6	24		14		11	6	434	" "	900	15.5	"	" "
Amazonas	Protect'd cruiser	330		43	9	25		16	10	3,450	Twin screws	7,500	20	2 military masts	Sir W. G. Armstrong, Whitworth & Co., Elswick, Newcastle-on-Tyne
Armeria	Lighth'se tender	212 ft. over all		34		17		12	6	.....	" "	200 nominal	12	2-masted sch'ner	Camden, N. J.
Atlas	Ocean tug	130		25	6	14	6	12	6	462	.....	650	13	Schooner	Harlan & Hollingsworth
Calumet	Rev.cut'r, 2d rate	94	6	20	6	10	3	8	8	123 R. T.	Single screw	500	13	Harbor tug	Buffalo, N. Y.
Columbia	Yacht	180		23		14	3	12		630	" "	1,800	18	Schooner	Wm. Cramp & Sons
Corwin	Revenue cutter	145	6	23		.....		11	5	213 registered	" "	350	10	"	Portland, Ore.
Creole	Coast liner	375		44		32	6	.....		6,000 loaded	" "	3,500	....	.....	Newport News S. B. & D. D. Co.
De Witt C. Ivins	Tug	97		21		11		8		156	.....	400	7	.....	Neafie & Levy
Diogenes	Gunboat	250		35		21	9	10		1,800	Twin screws	....	16	Schooner	Thames Iron Works
Edward Luckenbach	Ocean tug	88	6	21	6	10	6	9	3	227	Single screw	500 nominal	11	"	John Dialogue
El Norte	Coast.freightst'r	350	6	48		23	11	22		6,000 to 8,000	" "	8,800	....	Steamship	Newport News S. B. & D. D. Co.
El Rio	" "	390	6	46	10	23	11	22		" "	" "	3,600	17	"	" " " "
El Sol	" "	390	7	46	10	31	6	.....		" "	" "	3,800	....	"	Wm. Cramp & Sons
El Sud	" "	380		48		39	9	.....		" "	" "	3,600	....	"	Newport News S. B. & D. D. Co.
El Toro	Tug	90		19		10	9	9		187	" "	250	10	"	" " " "
Grant	Revenue cutter	163		25		11.4		9	6	263 registered	Screw	420	10	.....	Wilmington, Del.
Guthrie	Rev.cut'r, 3d rate	87		17		8	5	8	7	98 gross	Single screw	225	12	Harbor tug	Baltimore, Md.
Hamilton	Rev.cut'r, 2d rate	144 ft. over all		23		11	10	9	7	250	" "	450	12	.....	Buffalo, N. Y.
Hermione	Yacht	145		22	6	13		11		375	" "	1,000	14.5	Schooner	Fleming & Ferguson, Paisley, Scotl'd
Hudson	Rev.cut'r, 3d rate	96	6	18	4	9	2½	9		174	" "	525	13.5	Harbor tug	Camden, N. J.
Josephine	Yacht	225		25		14		14		800	" "	1,000	12.5	.....	Lewis Nixon
Lebanon	Collier	246		37	5	22	5	.....		3,500 loaded	" "	1,000	....	Schooner	Wm. Cramp & Sons
Mangrove	Lighth'se tender	164 ft. over all, 159 ft. between perps.		30		11	10	8		392 gross	Twin screws	650	9	"	Lewis Nixon
Manning	Rev.cut'r, 1st rate	205		32		17		10	10	900	Single screw	2,000	16	Brigantine	East Boston, Mass.
Maple	Lighth'se tender	164 ft. over all, 155 ft. between perps.		30		11	10	.....		392.06 gross	Twin screws	650 nominal	9	2-masted sch'ner	S. L. Moore & Sons, Elizabeth, N. J.
Mayflower	Yacht	275		36	6	30 ft. to b'ge deck		17	2½	2,690	" "	4,600	16.75	Brigantine	Clydebank, Scotland.
Mayflower	Lighth'se tender	164		30		11	10	8		392.06 gross	" "	650	9	2-masted sch'ner	Bath Iron Works
McCulloch	R'v.cut,comp'site	219		33	4	17	10	14		1,280	Single screw	2,300	17.23	3-masted sch'ner	Cramps, Philadelphia, Pa.
Merrimac ‡‡	Freighter	330		44		29		.....		2,556 net	" "	280	....	.....	C. L. Swan & Hunter, Newcastle
Morrill	Rev.cut'r, 2d rate	145	3	24		12	3	8	6	322	" "	500	12	Schooner	Camden, N. J.
Nanshan ¶	Emigrant and cargo steamship	285		39	1	24 ft. unloaded		Light		3,400 deadw'ght	" "	....	13	"	Grangemouth Dock Yard Co.
Niagara	Passenger st'mer	274		38		25		19	6	5,221	" "	1,600	12	"	J. Roach & Son
Nictheroy §	Dynamite cruiser	380		48		.....		22		7,080	" "	4,000	18	.....	Newport News S. B. & D. D. Co.
P. H. Wise	Tug	84		19		9		8		155	" "	290	10	.....	Neafie & Levy
Paoli ††	"	125	5	26		14	8	.....		330.71 gross	" "	600 nominal	....	Steamship	Chas. K. Hillman, Philadelphia
Perry	Revenue cutter	165		25		11	2	.....		282 gross	" "	400	11	Schooner	Buffalo, N. Y.
R. W. Wilmot	Tug	156	8	28		17		.....		.....	" "	2,000	....	"	F. W. Wheeler & Co., West Bay City
Rush	Revenue cutter	175		26		15		12	6	300 gross	" "	550	10.5	.....	Port Blakely, Wash.
Saturn	Salvage steamer	295 ft. over all		40		26	2	22 loaded		4,500 loaded	" "	1,300	12.5	Schooner	Harlan & Hollingsworth
Sovereign	Yacht	250 ft. 6 in. over all, 210 ft. 6 in bet. perps.		28	1	16	9	11	6	850	Twin screws	2,800	17.85	.....	Hull, John N. Robins; engines, W. & A. Fletcher
Sterling	Freighter	274		37		23	2	.....		5,663 loaded	Single screw	200	11	Schooner	Duncan & Co., Pt. Glasgow, Scotland
St. Louis	Transatl'tic liner	535.5		63		50.4		.....		11,629	Twin screws	18,000	20.87	2 pole	Wm. Cramp & Sons
St. Paul	" "	535.5		63		50.4		.....		11,629	" "	20,000	21.08	2 pole	" "
W. A. Luckenbach	Ocean tug	199	3	25		14	8	12		441	Single screw	750	12	Schooner	John Dialogue
Windom	Rev.cut'r, 1st rate	170	8	27		13	5	8	3	550	Twin screws	810	14	2 pole masts	Dubuque, Iowa
Winthrop	Ocean tug	125		26		15		14		571	Single screw	....	14	Schooner	Chas. K. Hillman & Co.
Woodbury	Rev.cut'r, 2d rate	146	6	28	6	11		11		330 gross	" "	500	11	"	Philadelphia
Zafiro ¶	Cargo & pass. st'r	220		31	10	21	3	.....		1,100 gross	" "	200	12.5	.....	Hall, Russel & Co., Aberdeen
Unnamed	Torp'do b't, 1st cl.	152 (?)		.....		.....		.....		140 (?)	.....	2,500	25	.....	Schichau Elbing, Germany
Unnamed	Torpedo boat	61		9		.....		2	6	46	Single screw	....	17	.....	Yarrow

WARSHIPS AND AUXILIARY VESSELS RECENTLY ACQUIRED BY THE UNITED STATES NAVY BY PURCHASE, CHARTER OR TRANSFER—(Continued).

Old Name.	Date of Build'g	Hailing Port.	Name of Former Owner.	New Name.	New Class.	Commanding Officer.	Armament.	Complement. Officers.	Men.
Abrouill	1897	Brazilian Navy	Republic of Brazil	Albany	Protect'd cruiser	Not detailed	6 6-in. r. f., 4 4.7-in. r. f., 10 6-pdrs., 4 1-pdrs., 4 Maxims, 2 field guns	Not in Commission	
Ægusa*	1897	Palermo	Ignazio Florio	.....	Despatch boat	.....	.....	.....	
Alice	1882	Hartford, Conn.	.....	Alice	Supply boat	.....	.....	.....	
Alicia	1890	New York	H. M. Flagler	Hornet	Auxiliary gunb't	Lt. James M. Helm	1 6 pdr., 2 1-pdrs.	5	51
Almy	1890	"	F. Gallatin	Eagle	" "	Lt. Wm. H. H. South'rland	4 6-pdrs., 2 6-mm. Colts	5	60
Amazonas	1896	Brazilian Navy	Republic of Brazil	New Orleans	Protect'd cruiser	Capt. W. M. Folger	6 6-in. r. f., 4 4.7-in. r. f., 10 6-pdrs., 4 1-pdrs., 4 Maxims, 2 field guns	300 officers and men	
Armeria	1890	.....	United States	Armeria	.....	.....	.....	6	—
Atlas	1896	New York	Standard Oil Co.	Wompatuck	Auxiliary gunb't	Lt. C. W. Jungen	1 3-pdr., 1 Gatling	1	25
Calumet	1894	U. S. R. C. S.	United States	Calumet	Gunboat	.....	1 gun †	2	9 †
Columbia	1893	New York	J. Harvey Ladew	Wasp	Auxiliary gunb't	Lt. A. Ward	4 6-pdrs., 2 6-mm. Colts	5	51
Corwin	1876	U. S. R. C. S.	United States	Corwin	Gunboat	.....	3 guns †	8	32 †
Creole	1896	New York	Cromwell Line	Solace	Hospital ship	Comdr. A. Dunlop	.....	5	—
De Witt C. Ivins	1897	"	Moran Towing Co.	Nezinscot	Water boat	Mate Cleveland	1 6-pdr., 1 Colt	1	12
Diogenes	1883	.....	Thames Iron Works, London, Eng.	Topeka	Gunboat	Lt. Com. W. C. Cowles	2 Long Toms, 1 stern chaser, 4 Maxims	.....	
Edward Luckenbach	1896	New York	L. Luckenbach	Tecumseh	Auxiliary gunb't	Lt. J. G. Evans	1 1-pdr., 1 Gatling	1	12
El Norte	1892	"	Morgan Line	Yankee	Auxiliary cruiser	Comdr. W. H. Brownson	10 6-in., 6 6-pdrs.	N. Y. Naval Militia	
El Rio	1892	"	" "	Prairie	" "	Comdr. C. J. Train	8 6-in., 2 5-in. r. f., 6 6-pdrs.	Mass. Naval Militia	
El Sol	1890	"	" "	Yosemite	" "	Comdr. W. H. Emory	10 5-in. r. f., 6 6-pdrs.	Mich. Naval Militia	
El Sud	1892	"	" "	Dixie	" "	Comdr. C. H. Davis	" " "	Md. Naval Militia	
El Toro	1891	"	" "	Algonquin	Auxiliary gunb't	Ensign W. S. Crossley	1 6-pdr., 1 6-mm. Colt	1	12
Grant	1871	U. S. R. C. S.	United States	Grant	Gunboat	.....	4 guns †	.....	
Guthrie	1895	"	" "	Guthrie	"	.....	.....	2	8 †
Hamilton	1871	"	" "	Hamilton	"	.....	1 gun †	7	32 †
Hermione	1891	Boston	H. L. Pierce	Hawk	Auxiliary gunb't	Lt. J. Hood	2 6-pdrs., 2 6-mm. Colts	5	42
Hudson	1893	U. S. R. C. S.	United States	Hudson	Gunboat	.....	1 gun †	2	9 †
Josephine	1896	Philadelphia	P. A. B. & G. D. Widener	Vixen	Auxiliary gunb't	Lt. A. Sharp	.....	.....	
Lebanon	1894	"	Philadelphia & Reading R. R.	Lebanon	Collier	Comdr. Force	.....	5	—
Mangrove	....	United States	United States	Mangrove	Auxiliary gunb't	Lt. Comdr. Wm. Everett	.....	4	—
Manning	1897	U. S. R. C. S.	" "	Manning	Gunboat	.....	1 gun †	7	40 †
Maple	1892	"	" "	Maple	Auxiliary gunb't	Lt Comdr. W. Kellogg	.....	4	—
Mayflower	1897	New York	Estate of Ogden Goelet	Mayflower	Torpedo gunboat	Comdr. M. R. S. Mackenzie	2 5-in. r. f., 12 6-pdrs., 2 torpedo tubes, 2 6-mm. Colts	9	152
Mayflower	1897	.....	United States	Suwanee	Auxiliary gunb't	.....	.....	.....	
McCulloch	1897	U. S. R. C. S.	" "	McCulloch	Gunboat	.....	4 guns †	8	45 †
Merrimac ‡‡	1894	New York	T. Hogan & Sons	Merrimac	Collier	Comdr. J. M. Miller	.....	.....	
Morrill	1889	U. S. R. C. S.	United States	Morrill	Gunboat	.....	1 gun †	7	32 †
Nanshan ¶	1895	London	T. W. Richardson, London	Nanshan	Collier	.....	.....	.....	
Niagara	1877	New York	New York & Cuba Mail S. S. Co.	Niagara	"	.....	2 6-pdrs.	5	48
Nichtheroy §	1893	Brazilian Navy	Republic of Brazil	Buffalo	Dynamite cruiser	.....	1 15-in. pneumat. dynam. gun, 14.7 & 2 3.9 in. r. f., 8 6 & 10 1 pdrs., 4 torpedo tubes	.....	
P. H. Wise	1892	New York	Moran Towing Co.	Sioux	Auxiliary gunb't	Ensign W. R. Gherardi	1 6-pdr., 1 Colt	1	12
Paoli ††	1895	Fall River, Mass	Staples Coal Co.	.....	.....	.....	.....	.....	
Perry	1884	U. S. R. C. S.	United States	Perry	Gunboat	.....	2 guns †	7	32 †
R. W. Wilmot	1897	New Orleans	W. G. Wilmot, New Orleans	Potomac	.....	Lt. Blow	.....	.....	
Rush	1885	U. S. R. C. S.	United States	Rush	Gunboat	.....	3 guns †	8	32
Saturn	1890	Boston	Boston Towboat Co.	Saturn	Collier	.....	.....	.....	
Sovereign	1896	New York	M. C. D. Borden	Scorpion	Auxiliary gunb't	Lt. Comdr. Marix	4 5-in. r. f., 6 6-pdrs., 4 6-mm. Colts	6	—
Sterling	1881	"	C. A. Campbell & Co.	Sterling	Collier	.....	2 6-pdrs.	5	44
St. Louis	1895	"	International Navigation Co.	St. Louis	Auxiliary cruiser	Capt. F. R. Goodrich	Proposed 18-in. b. l. r., 5 5-in. q. f., 10 9-in. smooth bores, — 6-pdrs.	.....	
St. Paul	1895	"	" " "	St. Paul	" "	Capt. C. D. Sigsbee		.....	
W. A. Luckenbach	1893	"	L. Luckenbach	Uncas	Auxiliary gunb't	Lt. F. R. Brainard	1 1-pdr., 1 Gatling	1	12
Windom	1896	U. S. R. C. S.	United States	Windom	Gunboat	.....	3 guns †	7	37 †
Winthrop	1896	Taunton	Staples Coal Co.	Osceola	Auxiliary gunb't	Lt. J. L. Purcell	1 3-pdr., 1 Gatling	1	12
Woodbury	1864	U. S. R. C. S.	United States	Woodbury	Gunboat	.....	2 guns †	7	32 †
Zafiro ¶	1884	Hong Kong	China & Manila S. S. Co.	.....	Armed transport	.....	.....	.....	
Unnamed	....	.....	.....	Somers	Torpedo boat	.....	2 torpedo tubes	Not in Commission	
Unnamed	....	.....	Yarrow	Manly	Despatch boat	.....	2 Hotchkiss r. f., 1 torpedo tube	.....	

* Bought in Italy. † These figures are for the Revenue Cutter Service. Corresponding ones for the Navy have not yet been determined. ¶ Reported bought by Commodore Dewey, on the Asiatic Station. § Originally the Morgan liner El Cid. †† Will be purchased only in case of war. ‡‡ Formerly Norwegian steamer Solveig.

REPORT OF THE "MAINE" NAVAL COURT OF INQUIRY.

A SUBMARINE MINE CAUSED THE PRIMARY EXPLOSION.

Finding of the Court Containing this Conclusion—Lengthy Extracts from the Testimony in the Original Text—Reproduction of Many Official Views and Drawings of the Wreck.

In this issue we are able to give to our readers excerpts from the official report of the Naval Court of Inquiry upon the destruction of the battleship Maine, February 15 last. This report formed part of a recent message of the President to Congress, and was, of course, discussed in its political aspects in the daily press, in which, however, technical details were omitted. We also reproduce all the engravings and drawings of importance which accompany the report. With the aid of these and the sectional views of the vessel, published in our March issue, our readers can intelligently follow the evidence and findings. It would not be possible, of course, in the limits of a periodical, to reprint the entire report, nor indeed would it be desirable to do so, for of necessity much of the matter contained in it is merely repetition, with such differences as the personal observation of many individuals would account for. All the salient points, however, are covered. As far as possible we use the original wording of the report, printing these extracts in smaller type, so that they can be readily distinguished.

The board, as our readers are aware, was composed of the following naval line officers: Captain William T. Sampson, president; Captain French E. Chadwick and Lieutenant-Commander William B. Potter, members, and Lieutenant-Commander Adolph Marix, judge advocate. The court commenced its sessions on the U. S. lighthouse tender Mangrove, at Havana, February 21, and remained there until March 15, after which it went to Key West, where the decision was reached March 21. In the words of the report this reads:

After full and mature consideration of all the testimony before it, the court finds as follows:

1. That the United States battleship *Maine* arrived in the harbor of Havana, Cuba, on the 25th day of January, 1898, and was taken to buoy No. 4, in from 5 1-2 to 6 fathoms of water by the regular government pilot.

The United States Consul-General at Havana had notified the authorities at that place, the previous evening, of the intended arrival of the *Maine*.

2. The state of discipline on board the *Maine* was excellent, and all orders and regulations in regard to the care and safety of the ship were strictly carried out.

All ammunition was stowed in accordance with prescribed instructions, and proper care was taken whenever ammunition was handled.

Nothing was stowed in any one of the magazines or shell rooms which was not permitted to be stowed there.

The magazines and shell rooms were always locked after having been opened, and after the destruction of the *Maine* the keys were found in their proper place in the captain's cabin, everything having been reported secure that evening at 8 p. m.

The temperatures of the magazines and shell rooms were taken daily and reported. The only magazine which had an undue amount of heat was the after 10-inch magazine, and that did not explode at the time the *Maine* was destroyed.

The torpedo war heads were all stowed in the after part of the ship, under the ward room, and neither caused nor participated in the destruction of the *Maine*.

The dry gun-cotton primers and detonators were stowed in the cabin aft, and remote from the scene of the explosion.

Waste was carefully looked after on board the *Maine* to obviate danger. Special orders in regard to this had been given by the commanding officer.

Varnishes, driers, alcohol and other combustibles of this nature were stowed on or above the main deck and could not have had anything to do with the destruction of the *Maine*.

The medical stores were stowed aft, under the ward room, and remote from the scene of the explosion.

No dangerous stores of any kind were stowed below in any of the other storerooms.

The coal bunkers were inspected daily. Of those bunkers adjacent to the forward magazines and shell rooms four were empty, namely: B3, B4, B5, B6. A15 had been in use that day, and A16 was full of New river coal. This coal had been carefully inspected before receiving it on board. The bunker in which it was stowed was accessible on three sides at all times, and the fourth side at this time on account of bunkers B4 and B6 being empty. This bunker, A16, had been inspected that day by the engineer officer on duty.

The fire alarms in the bunkers were in working order, and there had never been a case of spontaneous combustion of coal on board the *Maine*.

The two after boilers of the ship were in use at the time of the disaster, but for auxiliary purposes only, with a comparatively low pressure of steam, and being tended by a reliable watch.

These boilers could not have caused the explosion of the ship. The four forward boilers have since been found by the divers, and are in a fair condition.

On the night of the destruction of the *Maine* everything had been reported secure for the night at 8 p. m. by reliable persons, through the proper authorities, to the commanding officer. At the time the *Maine* was destroyed the ship was quiet, and, therefore, least liable to accident caused by movements from those on board.

EXPLOSIONS.

3. The destruction of the *Maine* occurred at 9:40 p. m. on the 15th day of February, 1898, in the harbor of Havana, Cuba, she being at the time moored to the same buoy to which she had been taken upon her arrival. There were two explosions of a distinctly different character, with a very short but distinct interval between them, and the forward part of the ship was lifted to a marked degree at the time of the first explosion. The first explosion was more in the nature of a report like that of a gun, while the second explosion was more open, prolonged, and of greater volume. This second explosion was, in the opinion of the court, caused by the partial explosion of two or more of the forward magazines of the *Maine*.

CONDITION OF THE WRECK.

4. The evidence bearing upon this, being principally obtained from divers, did not enable the court to form a definite conclusion as to the condition of the wreck, although it was established that the after part

of the ship was practically intact, and sank in that condition a very few minutes after the destruction of the forward part.

The following facts in regard to the forward part of the ship are, however, established by the testimony:

A portion of the port side of the protective deck, which extends from about frame 30 to about frame 41, was blown up, aft, and over to port. The main deck, from about frame 30 to about frame 41, was blown up, aft, and slightly over to starboard, folding the forward part of the middle superstructure over and on top of the after part.

This was, in the opinion of the court, caused by the partial explosion of two or more of the forward magazines of the *Maine*.

5. At frame 17 the outer shell of the ship, from a point 11 1-2 feet from the middle line of the ship, and 6 feet above the keel when in its normal position, has been forced up so as to be now about 4 feet above the surface of the water, therefore about 34 feet above where it would be had the ship sunk uninjured.

The outside bottom plating is bent into a reversed V shape (∧) the after wing of which, about 15 feet broad and 32 feet in length (from frame 17 to frame 25), is doubled back upon itself against the continuation of the same plating, extending forward.

At frame 18 the vertical keel is broken in two, and the flat keel bent into an angle similar to the angle formed by the outside bottom plating. This break is now about 6 feet below the surface of the water, and about 30 feet above its normal position.

In the opinion of the court this effect could have been produced only by the explosion of a mine situated under the bottom of the ship at about frame 18 and somewhat on the port side of the ship.

6. The court finds that the loss of the *Maine* on the occasion named was not in any respect due to fault or negligence on the part of any of the officers or members of the crew of said vessel.

7. In the opinion of the court the *Maine* was destroyed by the explosion of a submarine mine, which caused the partial explosion of two or more of the forward magazines.

8. The court has been unable to obtain evidence fixing the responsibility for the destruction of the *Maine* upon any person or persons.

W. T. Sampson,
Captain, U. S. N., President.

A. Marix,
Lieut. Com. U. S. N., Judge-Advocate.

At the opening of the Naval Court of Inquiry, Captain Charles D. Sigsbee, commander of the "Maine," was the first witness called, and asked:

Q. When did you take command of the *Maine?*

A. On the 10th day of April, 1897.

Q. When did the *Maine* arrive at Havana the last time?

A. On the 24th day of January, 1898.

Q. About what time?

A. About half-past 9 in the morning.

Q. Do you know, or have you any reason to believe, that the authorities of Havana knew of the *Maine's* coming?

A. Yes; I understand that they were notified by the United States Consul-General.

Q. Upon your arrival, did you take a pilot?

A. I did; I took an official pilot sent off by the captain of the port of Havana.

Q. Did he berth the *Maine?*

A. He did.

Q. Where?

A. The berth is in the man-of-war anchorage off the Machina, or the Shears. It is to all appearances one of the regular mooring buoys of the place. My recollection is that the pilot said that it was buoy No. 4. Our bearings, taken soon after mooring, did not place it exactly according to the charted position of buoy No. 4, but no note was taken of this because it was assumed that the charted position might represent former positions, and the buoys might have been changed somewhat in the examinations of the moorings.

Q. Have you been to Havana before frequently or recently?

A. I was here about 1872, and again about 1878.

Q. Do you know if you were placed in the usual berth for men-of-war?

A. No. I can only state that by remarks I have heard since the explosion.

Q. State what you heard.

A. I have been informed, since the explosion on board the *Maine*, by Captain Stevens, who is temporarily in command of the steamer *City of Washington*, of the Ward Line of steamers, that he had never known in all his experience, which covers visits to Havana for five or six years, a man-of-war to be anchored at that buoy, and that he had rarely known merchant vessels to be anchored there, and that it was the least used buoy in the harbor.

Q. Will you please describe the surroundings when first moored to this buoy?

A. The Spanish man-of-war *Alfonso XII* was moored in the position now occupied by the *Fern*—about 250 yards to the northward and westward of the *Maine*. The German ship *Gniesenau* was anchored at the berth now occupied by the Spanish man-of-war *Segaspe*, which is about 400 yards about due north from the *Maine*. A day or two after the arrival of the *Maine* the German man-of-war *Charlotte* came in and was anchored about four or five hundred yards to the southward of the *Maine's* berth. Other vessels, merchant vessels, came and went, anchored and moored in localities more or less remote, from 200 yards upward.

Q. Will you please describe your surroundings at the time of the explosion?

A. It was a calm and still night. At the time of the accident the Spanish man-of-war *Alfonso XII* was at the berth, as before stated. The small Spanish dispatch boat *Segaspe* had come out, I think, the day before and taken the berth occupied by the Spanish man-of-war, the *Gniesenau* having left. The steamer *City of Washington* was anchored about two hundred yards to the southward and eastward of the *Maine's* stern, slightly on the port quarter. That is as much as I can give. Other vessels were remote, so far as my recollection goes.

Q. When did you coal before the last coaling?

A. We coaled at Key West within a week of the time of our arrival.

Q. How much coal did you take at that time, if you remember?

A. I think about one hundred and fifty tons.

Q. Was the coal regularly inspected?

A. My recollection is that it was. It was from the government coal pile, and we had the usual men on shore; and while I cannot now state specifically, it was our invariable custom on board the *Maine* to inspect all coal before it was brought on board.

Q. How much coal did you take in the last coaling previous to this, and where?

A. It was at Key West, and I think in the neighborhood of 300 tons.

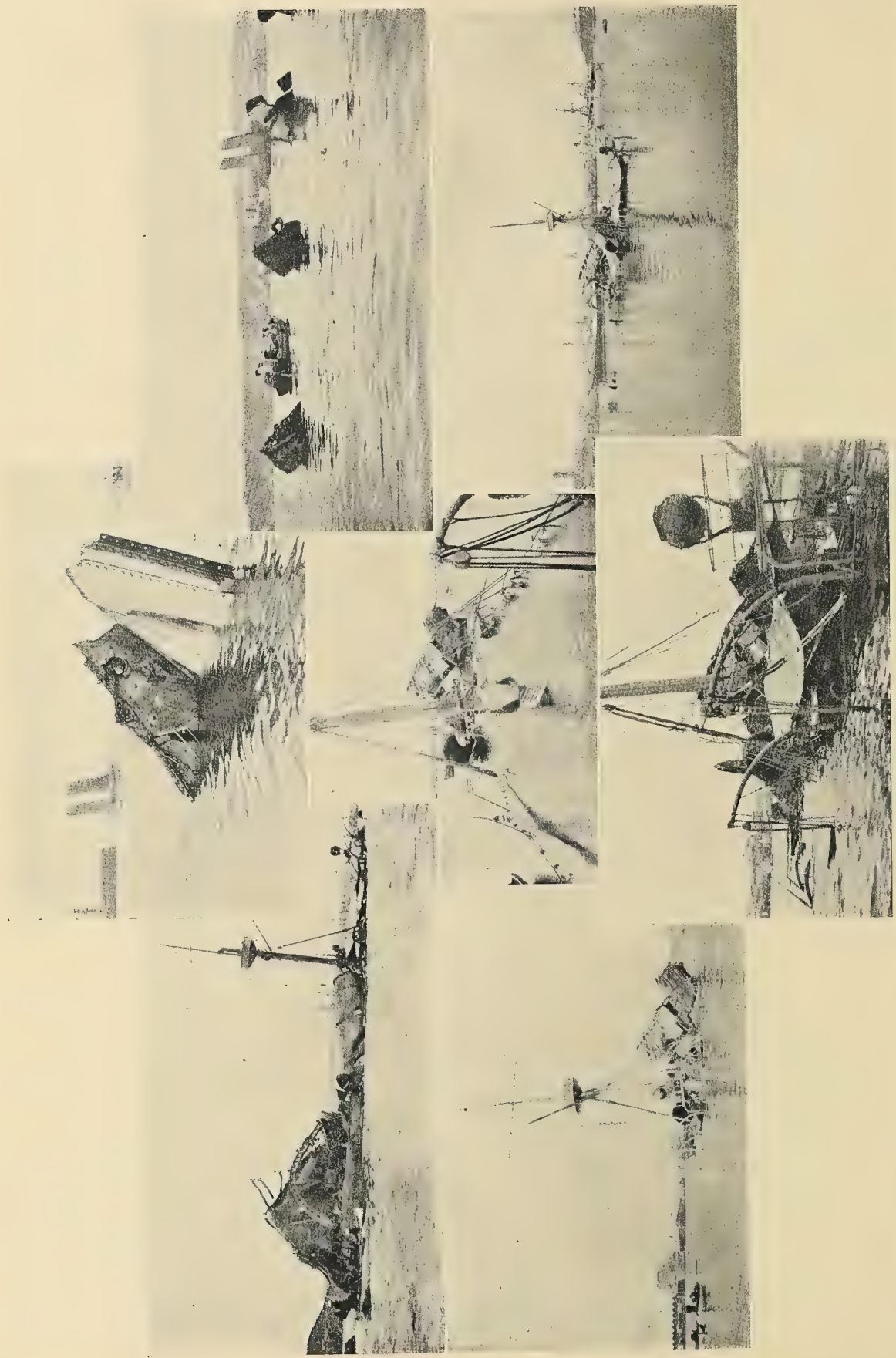
Q. Into what bunkers was the coal placed at these coalings?

A. Generally in the forward bunkers, because it was customary to use coal from the forward bunkers first. These bunkers naturally, therefore, were replenished with new coal.

Q. There is a peculiar bunker under the forward turret, abreast the 10-inch magazine. Do you know when that was last emptied?

A. I cannot personally recollect that particular bunker.

Q. Did you ever receive any report from the chief engineer of your ship that any coal had been too long in any bunker?



OFFICIAL PHOTOGRAPHS OF THE WRECK OF THE "MAINE" IN HAVANA HARBOR—REPRODUCED FROM THE REPORT OF THE COURT OF INQUIRY.

OFFICIAL PHOTOGRAPHS OF THE WRECK OF THE "MAINE" IN HAVANA HARBOR—REPRODUCED FROM THE REPORT OF THE COURT OF INQUIRY.

A. Never that I can recollect.

Q. Did the fire-alarms in the bunkers work?

A. They were sensitive. They worked occasionally when there was no undue heat in the bunkers, on which occasions we invariably examined the bunkers and got a report.

Q. Regarding inflammables and paints on board the *Maine*, were the regulations strictly carried out in regard to the stowage?

A. Strictly, so far as my knowledge and my orders were concerned. I was very particular on points of that kind. I was especially particular in my directions to the chief engineer concerning the disposition of waste which had been used. He had informed me that it was always kept in a covered metal bucket until thrown overboard with the ashes. He has since informed me that it was habitual to throw it overboard every day with the ashes.

Q. How often did you discharge ashes in Havana?

A. I cannot now recollect; but I remember giving certain directions in connection with hired lighters and not dumping in the harbor. The chief engineer was generally very solicitous about getting ashes out of the ship promptly.

Q. Where were ashes kept until discharged?

A. Those that I saw were dumped about the region of the bulkhead between the two fire rooms. There was a passage out of the forward part of the forward fire room which would have been blocked by ashes.

Q. Regarding paints and inflammables, was there not a paint room well forward below the berth deck?

A. The paint room was in what is called the eyes of the ship, just below the berth deck, the extreme forward compartment.

Q. What were the regulations in regard to that paint room? Was the painter allowed to stow any inflammables there?

A. He was not. The inflammables were stowed in chests aft, according to regulations, and when inflammables were in excess of our chest capacity they were allowed to be kept in the bathroom of the port or admiral's cabin.

Q. I believe Japan dryers, turpentine, and such were kept forward inside the superstructure. Am I not correct?

A. That is my recollection.

Q. Regarding the electric plant of the *Maine*, have you any reason to believe, from your observation of the lights or from any reports that may have been made to you, that there had been serious grounding?

A. None whatever; and there was no sudden flaring up of the lights before the explosion.

Q. No perceptible disturbance of the lights?

A. None whatever; there was a sudden and total eclipse.

Q. What were the regulations of the ship in regard to taking the temperature of the magazines, etc.?

A. There were no special regulations other than those that were regulations. The magazines were examined according to regulations, and reports made accordingly and sent to the Department. I always examined the temperature myself and conversed with the ordnance officer as to the effect of various temperatures on the contents of the magazines, and in his opinion, and my own, the temperatures were never near the danger point. I do not think there was any laxity in this direction. I cannot recollect any. When I joined the ship I found it was considered unnecessary to use slippers in the magazine, and I directed that they should be used.

Q. Do you recollect any work going on in the magazine or shell rooms on the day of the disaster?

A. My recollection is that the keys were called for that morning at quarters in the usual way. I cannot recollect any other call for the keys on that day.

Q. Were the keys properly returned after quarters?

A. Yes; so far as I can recollect. The regulation reports were made at 8 o'clock by the executive officer. The keys of all the shell rooms and magazines, and the spare keys, have been recovered by the diver in my stateroom, where they were always kept.

Q. At the time of the disaster what boilers were being used?

A. The two after boilers in the after fire room. More than one boiler was in use, for the reason that our hydraulic system was somewhat leaky.

Q. Please inform the court in a general way, giving any particulars you wish to give, in regard to your relations to the Spanish authorities and native authorities or people, from the time of the arrival of the *Maine* until the time of your disaster.

A. My relations with the officials were outwardly cordial, and I have no ground for assuming that they were not really cordial. The members of the autonomistic council of the government, however, seemed to have brought to the attention of the Navy Department the fact that I did not visit them. They made me no suggestions to visit them. From the letters and telegrams received from the Navy Department there seems to have been some embarrassment caused the government at Washington by the fact that I made them no visit. I took the ground to the department that it was unknown etiquette to call on the civil members of the colonial government other than the governor, but that I would have exceeded etiquette at any time on suggestion from the council. Without waiting for orders I made a visit afterwards. My visit was pleasantly received, and promptly returned by certain members of the council. They sent on board a large party of ladies a day or two afterwards. The president of the council, on board the *Maine*, made me a very cordial address, which I could not understand, and which was interpreted to me briefly. I replied briefly, expressing kind sentiments and a hope for the continuance of cordial relations between Spain and the United States. Fancying that some expression cordial to the colonial or autonomistic government might be expected of me, I evaded the point, and used only this expression: "I beg to express my admiration for the high purpose of your honorable body." My reply was afterwards printed in at least two papers in Havana, but the terms made me favor autonomistic government in the island. I am informed that the autonomistic government in Havana is unpopular among a large class of Spanish and Cuban residents. I have no means of knowing whether my apparent interference in the political concerns of the island had any relation to the destruction of the *Maine*.

Q. Was there ever any demonstration of animosity by people afloat?

A. Never on shore, so far as I am informed; but afloat there was a demonstration. It was the first Sunday after our arrival, on board a ferryboat, densely crowded with people, both civil and military, who were returning to Havana from a bull fight in Regla. The demonstration consisted of yells, whistles, and apparently derisive calls emanating from about thirty or forty people at most. It was not general.

Q. During the stay of the *Maine* at Havana did you take other than the ordinary precautions which are usually taken on every man-of-war for her protection?

A. I did.

Q. Please state them fully.

A. I had sentries on the forecastle and poop, quartermaster and signal boy on the bridge, signal boy on the poop; the corporal of the guard especially instructed to look out for the port gangway; the officer of the deck and quartermaster especially instructed to look out for the starboard gangway; a quarter watch was kept on deck all night; sentries' cartridge boxes were filled, their arms kept loaded, a number of rounds of rapid-firing ammunition kept in the pilot house, and, in the spare captain's pantry, under the after superstructure, additional charges of shell close at hand for the secondary battery; steam kept up in two boilers instead of one; especial instructions given to watch carefully all the hydraulic gear and

report defects; the officer of the deck charged with the necessity for making detailed reports to me, even in minor matter. I had personally instructed the master at arms and the orderly sergeant to keep a careful eye on everybody that came on board, and to charge all their subordinates to the same purpose. I instructed them that, when any persons came on board to go below, they were to go with them, and carefully observe any packages that might be held, on the supposition that dynamite or other high explosive might be employed; and to afterwards inspect the routes these people had taken, and never to lose sight of the importance of my order. I further instructed the marine officer to make at least two visits during the night to the posts of the vessel. The whole purport of my orders and directions was that we should consider the *Maine* in a position demanding extreme vigilance. Doubtless I gave many other detailed orders of a minor character that I cannot now recall.

Q. Regarding strangers being in the ship, at what time were they compelled to leave the ship?

A. I think Lieutenant-Commander Wainwright was rather severe on desultory visitors. Very few visited the ship, except people of the highest social standing in the city. They came commonly from 2 to say 5 o'clock. They were always accompanied about the ship by officers, and of course under the supervisory orders of the master at arms and sergeant of marines. People were allowed to visit the ship from about 10 to 12, and about 1 to 4. I think there were but two visits of Spanish military officers. Once, about two weeks ago, a party of five or six Spanish officers came on board during my absence. They were reported to me as having been constrained, and not desirous to accept much courtesy. They accepted no refreshments, but I afterward learned that it is a Spanish custom not to accept refreshments unless they are at hand at the time the offer is made. On another occasion, about the same time, a Spanish officer came off with his wife. He made a visit to my cabin, and was shown about the ship by an officer under my direction. I invited Spanish officers to visit the ship; in fact, I made considerable effort to get them on board socially in order to show good will according to the spirit of the *Maine's* visit to Havana; but, with the exceptions noted, no military officer of Spain visited the ship socially, so far as I can remember. I know that the purser of the *Alfonso XII* made a social visit; but I cannot recollect a purely social visit from other Spanish officers. The wardroom officers of the *Maine*, perhaps, have further information on this point.

Q. Among the precautions which you took was the fact of having extra lookouts on the deck. Was there ever any report of any unauthorized boats attempting to approach the ship and being ordered off?

A. Never, to my knowledge.

Q. On the night of the disaster, were all your extra precautions in force? I mean, in regard to quarter watches?

A. I assume that they were; they were never rescinded, and up to the night of the explosion, as far as my observation could go, my knowledge is that they were carried out. I was especially impressed during the whole visit here by the prompt tendency of the sentries to report any infractions of orders on the part of the crew.

Q. At the time of the accident, do you know what boats were down, and where?

A. I assume that one of the cutters was down, and one of the steam launches. I think the first steam launch was down. The steam launch, I have since been informed, was riding at the starboard boom, and that one of her crew was saved. He is now in the hospital at Havana.

Q. What kind of a night was it at the time of the explosion?

A. It was a very quiet and warm night, and I remember distinctly that the echoes of the bugle at tattoo were singularly distinct and pleasant. A little rain fell after the explosion, which may have been precipitated by the concussion of the explosion.

Q. Was it a dry night?

A. There were stars, but I think it was somewhat overcast. I think I saw several stars after the accident, but it was somewhat overcast according to my recollection.

Q. How was the *Maine* heading at the time of the explosion?

A. Approximately northwest. She pointed toward the shears—somewhat to the right of the shears, near the admiral's residence.

Q. Where were you at the time?

A. I was writing at my port-cabin table, after side. I was dressed.

Q. Please give your experience in full.

A. I was just closing a letter to my family when I felt the crash of the explosion. It was a bursting, rending, and crashing sound or roar of immense volume, largely metallic in its character. It was succeeded by a metallic sound—probably of falling débris—a trembling and lurching motion of the vessel, then an impression of subsidence, attended by an eclipse of the electric lights and intense darkness within the cabin. I knew immediately that the *Maine* had been blown up and that she was sinking. I hurried to the starboard cabin ports, thinking it might be necessary for me to make my exit in that way. Upon looking out I decided that I could go by the passage leading to the superstructure. I therefore took the latter route, feeling my way along and steadying myself by the bulkheads. The superstructure was filled with smoke, and it was dark. Nearing the outer entrance I met Private Anthony, the orderly at the cabin door at the time. He ran into me and, as I remember, apologized in some fashion, and reported to me that the ship had been blown up and was sinking.

I reached the quarter-deck, asked a few questions of those standing about me—Lieutenant-Commander Wainwright, I think, for one—then I asked the orderly for the time. He said that the exact time of the explosion was 9:40 p. m. I proceeded to the poop deck, stood on the side rail, and held on to the main rigging in order to see over the poop awning, which was baggy and covered with débris; also in order that I might observe details in the black mass ahead. I directed the executive officer to post sentries all around the ship, but soon saw that there were no marines available, and no place forward to post them. Not being quite clear as to the condition of things forward, I next directed the forward magazine to be flooded if practicable, and about the same time shouted out myself for perfect silence everywhere. This was, I think, repeated by the executive officer. The surviving officers were about me at the time on the poop. I was informed that the forward magazine was already under water, and after inquiring about the after magazine was told that it was also under water, as shown by the condition below reported by those coming from the wardroom and steerage.

About this time fire broke out in the mass forward, over the central superstructure, and I inquired as to the spare ammunition in the captain's pantry. That region was found to be subsiding very fast. At this time I observed, among the shouts or noises apparently on shore, that faint cries were coming from the water, and I could see dimly white, floating bodies, which gave me a better knowledge of the real situation than anything else. I at once ordered all boats to be lowered, when it was reported that there were only two boats available, namely, the gig and whaleboat. Both were lowered and manned by officers and men, and by my direction they left the ship and assisted in saving the wounded jointly with other boats that had arrived on the scene from the Spanish man-of-war, from the steamer *City of Washington*, and from other sources. Later—I cannot state precisely how long—these two boats of the *Maine* returned to the starboard quarter alongside, and reported that

they had gathered in from the wreck all the wounded that could be found and had transferred them to the other boats—to the *Alfonso XII* or to the *City of Washington.*

The poop deck of the *Maine,* the highest point, was by that time level with the gig's gunwale while she was afloat in the water alongside. The fire amidships was burning more fiercely and the spare ammunition in the pilot house was exploding in detail. We had done everything that could be done so far as I could see. Lieutenant-Commander Wainwright whispered to me that he thought the 10-inch magazine forward had been thrown up into the burning mass, and might explode in time. I directed him then to get everybody into the boats over the stern, and this was done, although there was some little delay in curbing the extreme politeness of the officers, who wanted to help me into the boat. I directed them to go first, as a matter of course, and I followed and got into the gig. We proceeded to the steamer *City of Washington,* and on the way I shouted to the boats to leave the vicinity of the wreck, and that there might be an explosion. I got Mr. Sylvester Scovell to translate my desire to one or two boats which were at that time somewhat nearer the fire than we ourselves were.

Having succeeded in this, I went on board the *City of Washington,* where I found our wounded all below in the dining saloon on mattresses, covered up, and being carefully attended by the officers and crew of that vessel. Every attention that the resources of the vessel admitted was being rapidly brought into use. I then went on deck and observed the wreck for a few minutes, and gave directions to have a muster taken on board the *City of Washington* and other vessels, and sat down in the captain's cabin and dictated a telegram to the Navy Department. At this time various Spanish officers—civil, military, and naval—appeared on board, in their own behalf and in representative capacity, expressing sympathy and sorrow for the accident. The representatives of General Blanco and of the admiral of the station came on board, and the civil governor of the province was on board in person. I asked them to excuse me for a few minutes, until I completed my telegram to the Navy Department.

After finishing the telegram and putting it in the hands of a messenger to be taken on shore, I conversed for a few minutes with the various Spanish gentlemen around me, thanking them for the visit and their sympathy. I was asked by many of them the cause of the explosion, and I invariably answered that I must await further investigation. For a long time the rapid-fire ammunition continued to explode in detail. The number of the wounded was reported to me later. I have some difficulty in remembering figures. I think we found about 84 or 85 men that night who survived. It was also reported to me that the wounded on board Spanish vessels had been taken to the hospitals on shore, as were also the survivors who had reached the machina, in the neighborhood of the shears on shore. To keep a clear head for the emergency I turned in about 2 o'clock, getting little sleep that night, owing to the distressing groans of the wounded.

Q. By the time you reached the quarter-deck, were all the large explosions over?

A. So far as my experience is concerned there was simply one impression of an overwhelming explosion. I do not recollect details. I have already stated the explosions of minor character.

Q. But you yourself saw no large upshoot of flame?

A. When I came from the cabin, I was practically blinded for a few seconds. I thought only of the vessel, and took no note of the phenomena of explosion. It is probable that the explosive column had subsided wholly or practically by the time I reached the deck. I am not sure, because of the intense darkness.

Q. You state in your story that the *City of Washington* attended to the wounded. Did not the Spanish man-of-war also do the same?.

A. I am not very sure personally, but the reports were that they were doing all that was possible. There was no reference to me on the part of the Spanish officers for sending the wounded on shore. I assume and believe that they did everything in their power to care for the wounded, and have continued to do so most conscientiously ever since.

Q. How many were wounded; how many killed; and how many were saved not wounded?

A. I would have to refer to my figures for that, and they are not now at hand. The muster, I think, shows 101 saved, including the wounded, and 253 lost. Some of the wounded have since died. My duties have been too complex since the explosion to enable me to memorize all the figures.

Q. From your examination of the wreck, as far as you have been able to make, what magazines or shell rooms, if any, should you say were blown up?

A. From the appearance of things about the wreck it is extremely difficult to come to any conclusion. The center of the explosion appears to have been beneath and a little forward of the conning tower, and on the port side. The forward part of the superstructure has been thrown upward backward over the after part and toward the starboad side, indicating an explosion on the port side of the ship. In the region of the center or axis of explosion was the 6-inch reserve magazine, which contained very little powder—probably, I am informed, about 300 pounds. The 10-inch magazine is in the general region, but it is on the starboard side, under the forward turret, which is well out on the starboard side. Over the 10-inch magazine in the loading room of the turret, and in the adjoining passage, and well on the starboard side, were a number of 10-inch shell, permanently placed. There were also several additional shell in the loading room. It is difficult, therefore, to conceive that the explosion involved the 10-inch magazine, because of the location of the explosion, and because I have had no reports that any 10-inch shell were hurled into the air by the explosion. The violence of the explosion, although not its immediate locality, indicates that the 10-inch magazine may have been involved.

Q. Where was the 10-inch shell room?

A. The 10-inch shell room was abreast the 10-inch magazine on the port side. It opened on the port side of the vessel.

Q. Was it not between the reserve 6-inch and 10-inch magazines?

A. It was.

Q. Do you know the thickness of the bulkhead between those three divisions?

A. I cannot recollect. I should say that it was of ordinary metal, the thickness of a bulkhead of similar construction in other parts of the ship.

Q. Do you know what was between the coal bunker and the magazine?

A. I think nothing but the ordinary steel plate. It is so aft.

Q. Where was the small-arm ammunition locker forward, and what was in it?

A. We had received a new supply of ammunition, and this was kept forward of the thwartship armor bulkhead. I mean the small-arm and rapid-fire ammunition.

Q. Was there any smokeless powder?

A. There was no great gun smokeless powder ammunition. All the great gun ammunition was the ordinary brown powder.

Q. Was there not a 6-inch ammunition room forward of the small-arm ammunition rooms?

A. There was; supply for the forward 6-inch guns.

Q. On what side was the powder stowed in that one?

A. I have visited it, but I cannot now exactly recall

the exact position of the stowage. I know the powder chute is on the starboard side?

Q. Do you think that the forward 6-inch magazine blew up?

A. I do not think so. I cannot find reason to suppose so. One man at least was blown out of the forward superstructure into the water. It is more than probable that he would have been blown to atoms if the magazine had exploded.

Q. Where did you keep your gun-cotton?

A. Aft, under the cabin. The war heads were all stowed in that part of the ship which was not affected by the explosion. It was away aft.

Q. Where were the gun-cotton primers and detonators kept?

A. They were always kept in my cabin.

Q. Was any torpedo of the *Maine* fitted with its war head at the time of the explosion?

A. It was not. They were put in especially good condition, but none were fitted with war heads.

Q. Please state all the steps you have taken since the accident to ascertain its cause, and any results you may have obtained.

A. I have examined the wreck myself, conversed with other officers and men, and to some slight extent, in a categorical way, with the Spanish admiral. I have had a board of three officers make inquiries throughout the bay, but I have not yet received the reports from all the officers; nor have I had time to read the preliminary reports now in hand. I have not sent down any divers until this morning, not having had the necessary facilities. The best divers here are apparently in the employ of private parties, and since the Spanish authorities are very much averse to an investigation except officially, on the ground, as stated by the Spanish admiral, that the honor of Spain is involved, I have foreborne to examine the submarine portion of the wreck for the cause of the explosion until this morning. The divers of the fleet are now at work. I have had divers down in the cabin, and have recovered by that means the cipher code and magazine keys.

Q. What was the state or the condition of the *Maine* as far as discipline was concerned?

A. It was excellent. This is attested by the fact that the *Maine* was chosen for the duty on which she was engaged. She would not have been chosen had she been in any other than good discipline. The marine guard was in excellent condition. The medical reports from the medical department will show, I think, that about one man and one-quarter per diem were on the sick list during the past year. In the paymaster's department I think I am justified in saying that none of the reports of the paymaster to the Government at Washington were returned to the vessel for correction during my period of command. In the engineer's department the vessel was always ready and always responsive. I can recollect no letter from any source relating to the engineer's department which could be considered in the least of an adverse nature, except that the bureau once objected to a boiler being used in any degree as a tank. I think the punishment reports of the *Maine* are as small as those of any other vessel of the Navy in proportion to complement. They were uncommonly small. A quieter, better-natured, well-ordered, and apparently satisfied crew I have never known on board any vessel in which I have served.

Q. Have you any fault to find with the behavior of any officer or man at the time of the disaster?

A. None. I consider that the conduct of all was admirable. The behavior of the officers toward me personally and the prompt and responsive recognition of my authority was admirable, and instances of bravery are known both among the officers and crew in the direction of rescuing shipmates.

(The judge-advocate announced that at present he had no further questions to ask Captain Sigsbee.)

Examination by the COURT:

Q. What is the highest temperature you remember to have been reported in the forward magazines?

A. The highest temperature that I remember—and I think I can recall the figures—was 112°; but that was in the after magazines, where the temperatures were higher than in the forward magazines. I do not recollect the temperature in the forward magazines, because they were not so high as in the after magazine.

Q. Was any loose powder kept in the magazines, or was it all stowed in the usual air or water-tight cylinders, which each contains a charge?

A. I never permitted any to be kept loose, and do not believe that any was so kept.

Q. What was the status of the coal bunkers next to the forward magazines? Were they full, or had there been any coal used out?

A. All the bunkers were ventilated through air tubes, examined weekly by the chief engineer, and otherwise as was necessary, and they were connected electrically to the annunciator near my cabin door. The forward coal bunker on the port side was full, so I understand; the forward coal bunker on the starboard side adjoining the magazine has been reported to me as being one-half full, and it was in use at the time of the explosion.

The next witness was Lieutenant George F. M. Holman. Portion of his testimony is here given:

Q. What duty have you performed on board the *Maine* during that time?

A. The duty of navigator and ordnance officer.

Q. Did this duty also put you in charge of the electric plant?

A. Yes.

Q. Regarding the magazines of the *Maine*, what precautions do you know were taken for safety whenever the magazines were opened?

A. The usual precautions were taken with regard to all lights, if any were burning, and to stop smoking. The police, the master at arms, and others were always notified, and word sent, in fact, all over the ship. The galley was screened and the flag was hoisted in receiving ammunition on board, or putting it out. On all occasions, when magazines were opened, word was sent, as already said, all over the ship.

Q. What precautions were taken by the men in entering the magazines or shell rooms?

A. The question came up some time ago as to putting on the magazine shoes, that is, a short time after Captain Sigsbee took command. Prior to that time the order had not been enforced in regard to magazine shoes or slippers. Captain Sigsbee gave the order to make them wear their magazine shoes wher they went down.

Q. Were all other precautions taken described by regulations?

A. Yes; so far as I know.

Q. Please state whether any work had been going on in the magazine or shell rooms, or in the small-arm ammunition rooms, within a day or so of the explosion?

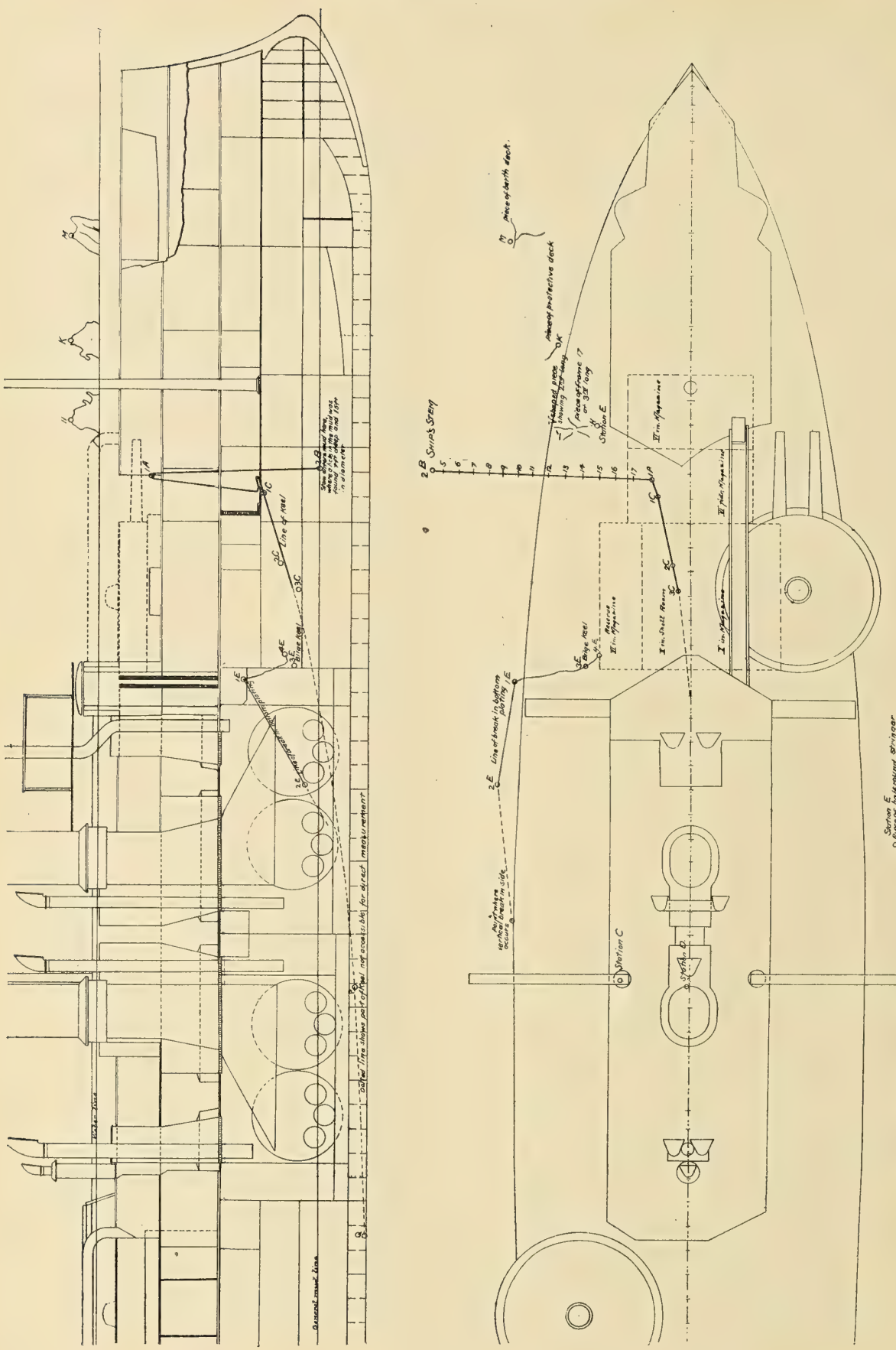
A. On Monday we had our usual drills, and part of it being a drill of the powder division at their stations. I do not know of any work going on around the magazines. I would, no doubt, have known if any had been undertaken.

Q. Please state to the court how the orders in regard to the taking of the temperatures of the magazines and shell rooms were carried out on board the *Maine*.

A. The temperature was taken daily of the magazines and shell rooms and ammunition rooms, and recorded in monthly reports to the Bureau.

Q. Was this fully carried out up to the time of the explosion?

A. I have no doubt that it was. I know of its having been carried out to within at least two or three days previous. I presume that it was carried out the remaining part of the time.



PROJECTION SHOWING PRESENT POSITION OF THE KEEL AND BOW OF THE "MAINE."—REPRODUCED FROM OFFICIAL REPORT.

Q. Who took this temperature?

A. The chief gunner's mate; previously the gunner.

Q. How high did the temperature reach during your experience on board the *Maine?*.

A. The hottest magazine was the 10-inch after magazine, where it reached as high as one hundred and ten in hot weather, remaining there for some time.

Q. Can you state to the court how much ammunition was stowed in the 6-inch reserve magazine which was on the port side of the ship abreast of the 10-inch shell room?

A. I think there were about 200 pounds of saluting powder in tanks. If there was any other powder there, it was of small amount. I am not sure.

British Coast Trade Passenger Steamer.

A fine addition to the Irish Channel fleet of the London and North Western Railway Co., S. S. Cambria is here shown, with a group containing the chief officials of the company. The new vessel is a twin-screw express passenger steamer carrying nothing in the holds except baggage and the parcel mail in transit for the British post office. She was built by William Denny & Brothers, of Dumbarton, and her dimensions are: Length, 337 ft. 6 in.; breadth, molded, 39 ft.; depth to awning deck, 24 ft. 9 in.

S. S. CAMBRIA FOR LONDON AND NORTH WESTERN RAILWAY CO., AND GROUP OF OFFICIALS.

Q. Were there any 6-inch charges stowed there?

A. I think not. We had room for all our 6-inch powder in the regular 6-inch magazines. I know of no 6-inch charges.

Q. How are the magazines and shell rooms on board the *Maine* constructed? Are they lined with wood?

A. No; the bulkheads are iron and not lined with wood. They are floored with gratings—a wooden flooring; the powder is kept on wooden racks. The shells are stowed in chocks.

(To be continued.)

Her gross tonnage is 1,842 tons. Forward the draught is 11 ft. 3 in. and aft 11 ft. 10 in. She is a handsome vessel of the seagoing type, built to withstand the tremendous gales which are encountered during much of the year. She has two pole masts and two stacks of the usual buff color, adopted by the company, with black tops.

The first-class dining room is on the main deck forward of the funnels and can accommodate eighty passengers at a sitting. It is finished in

waxed wainscoat oak, and the upholstery is terra cotta frieze velvet. The floor is laid with Brussels carpet and the ceiling finished in gold and white. The ladies' saloon on the main deck is finished in decorated sycamore panels and upholstered in blue frieze velvet. As the trip is so short little sleeping accommodation is necessary for the use of passengers. There are several other saloons for passengers of both sexes. In the steerage at the after end of the vessel there is also ample passenger accommodation. The crew are berthed forward in the forecastle, and the firemen amidships alongside the machinery spaces. The deck officers and engineers, with the exception of the chief officer and captain, are berthed in a house aft on the promenade deck. These officers have a separate house on top of the bridge deck.

KEY TO GROUP ON PAGE 25.

The triple-expansion engines are from the designs of Walter Brock and are balanced on the Yarrow-Schlick-Tweedy system. They have cylinders 26 in., 40 in. and two 43 in dia. There are 8 single ended boilers. There is a very complete installation of electric apparatus made at the railroad works of the company at Crewe.

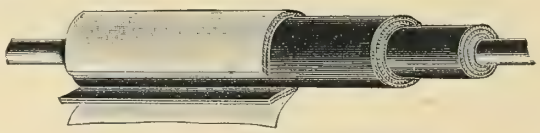
The mean speed of the Cambria on Clyde trials was 21.4 knots. Her first across-channel trip from the company's pier at Holyhead to the landing at the North Wall, Dublin, a distance of 64 miles, was made in 3 hours, 50 minutes. There was a gale blowing. A key to the group of persons gathered under the navigating bridge of the new vessel, page 25, is here given. The numbers and names are: (1) Lord Stalbridge, chairman of the London and North Western Railway Co.; (2) Captain Varian, commander of the vessel; (3) Peter Denny, shipbuilder of Dumbarton; (4) Joseph Bishop, secretary to Lord Stalbridge; (5) C. E. Grasmann, outdoor goods manager, Euston, London; (6) F. W. Webb, M.E., locomotive superintendent London and North Western Railway Co., Crewe; (7) A. J. Orr, superintending marine engineer; (8) Captain Binney, marine superintendent; (9) F. T. Hinsman, outdoor goods manager, Euston, London; (10) Mr. Whitlaw, Dublin agent; (11) F. Ree, chief goods manager; (12) G. W. Skipworth, Irish manager L. & N. W. Ry. Co.

This corporation is the largest in the United Kingdom, having a capital stock of about $500,000,000. The new boat is now in regular service under command of Captain Thomas James Varian, the commodore of the line.

IMPROVED APPARATUS.

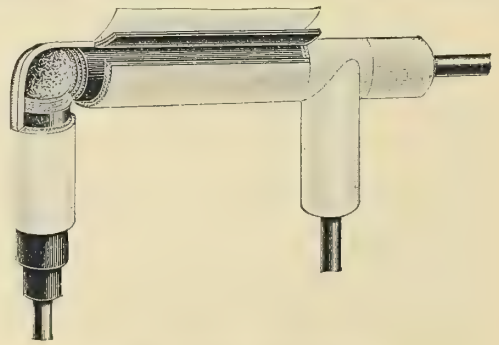
Gast's Brine Pipe Covering.

Pipe covering is usually associated with steam mains, but there is also a necessity for proper covering of pipes carrying brine in the refrigerating plant, which now forms a part of the machinery installation of every well-equipped vessel. Where these pipes are carried without



COVERING ON STRAIGHT PIPE.

any non-conducting covering there is, of course, a constant formation of ice, which has the familiar frosted appearance. This is quite unnecessary for the proper working of the plant and a nuisance besides, as variations of temperature in the plant, caused by stoppage for instance, cause drippings and general sloppiness. Gast's Air Cell Brine Pipe Covering, here illustrated, is guaranteed to effectually prevent the warm air of a compartment from reaching the actual pipe, thus preventing the condensation of the contained vapor on the pipes and accompanying losses by absorption of heat. The covering is composed of



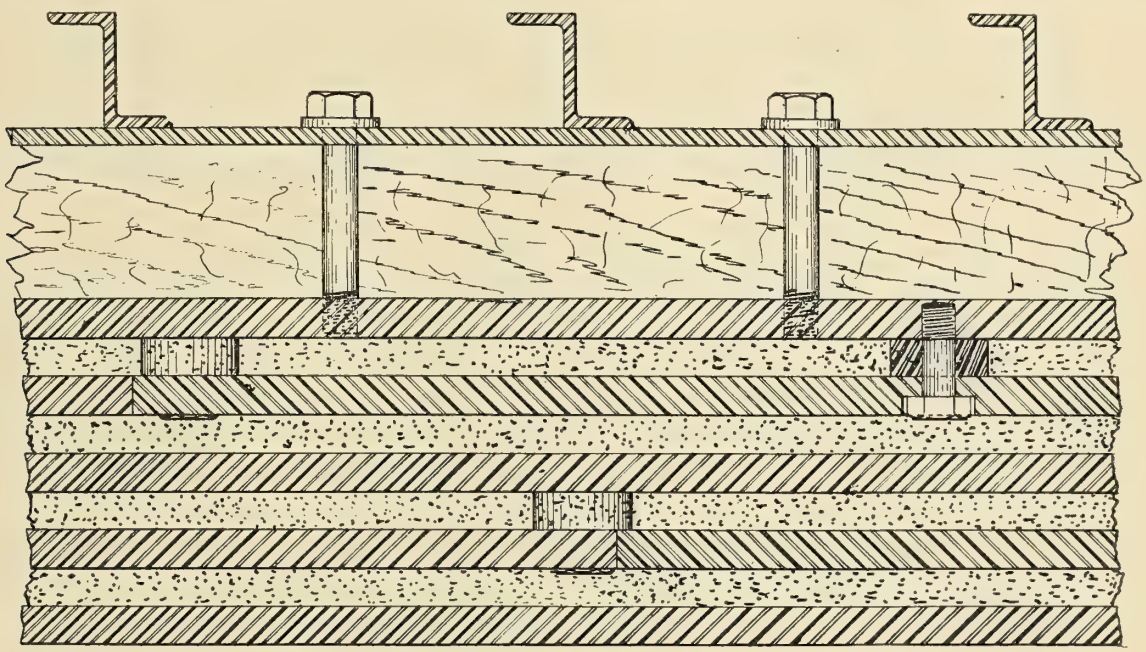
COVERING ON JOINTS.

water proof materials taking the form of a number of concentric rings of small air cells, each of which is air tight. The application of the covering is simple and the makers claim for it great durability. They also guarantee that the application of this covering to water pipes will prevent freezing, even at very low temperatures. It is made by the New York Fireproof Covering Co., 26 Cortlandt St., New York.

McAllister System of Armor Plating.

During the consideration of the Naval Appropriation bill in the House of Representatives, Congressman Mahon, of Pennsylvania, offered an amendment, appropriating $1,000 to be expended in testing the McAllister system of armor plating. Although the amendment was ruled out on a point of order, as being new legislation, it created considerable discussion and favorable comment from a number of influ-

ential members. The accompanying sketch will illustrate the ideas of the inventor, and they seem to be based on good mechanical principles. The object is to substitute a "built up" plate for the solid plate, which is now almost universally used. There have been many "built up" plates experimented with, but the system proposed is, for example, to use five 2 in. plates, with spaces of equal width between them, instead of a 10 in. solid plate. The principle involved is that advantage is taken of the elasticity of the metal, inasmuch as each plate in succession will have to be bent in so that it will touch its adjoining plate, before it can be punctured. A rather homely illustration of the principle is that of a man trying to drive a nail into a piece of thin wood which has no backing. The hammer will fly back, without the nail making much of an indentation into the wood, whereas if the strip is supported solidly at the back, no difficulty is encountered in driving the nail through the wood. In the proposed system, the plates are separated by steel washers through which tap bolts are used for securing the different layers in position. The spaces between the plates are to be filled with corn pith cellulose, a material very light and elastic, which possesses the additional quality of swelling out when wet, which would tend to close the hole, should the plate be entirely punctured. Experiments have been made by the inventor, on a small scale, which go to show that a plate built on this system possesses many points of excellence. Some of these are of special interest in these times of war preparation. (1.) It can be made for about one-quarter the cost of solid plate (now about $400 a ton), as any ordinary rolling mill can turn out plates of this description, while with the system now in vogue armor plate in this country can only be made by two steel mills. (2.) A much more uniform grade of material can be used, owing to the fact that each plate will receive the same amount of working in the process of manufacture. The Harveyized nickel steel plates have only the outer surface hardened for a depth of 1 to 1 1-2 in. In the proposed system, by the use of oil tempered, nickel steel, of high tensile strength, there will be six surfaces of uniform hardness, which must be punctured by a projectile before the plate is penetrated. (3.) With the use of solid plates there are, of necessity, joints where the plates butt together, which are undeniably sources of weakness. In the McAllister system, by "breaking joints" in the different layers, a practically continuous belt of armor plate is presented to the enemy's fire. (4.) The rapidity with which this system of armor plating could be manufactured and fitted to a vessel is certainly a great advantage, under circumstances like those existing at the present time. To make and secure in place the solid armor on a vessel like the "Kentucky" or "Kearsarge" would, under the most favorable conditions, occupy at least one year. The "built up" system, such as is illustrated here, could easily be applied to a battle ship within three or four months' time. This system has been brought to the attention of several armor experts, who agree that it is of sufficient promise to warrant a thorough test at the hands of the navy officials. It would certainly be a ready means of affording protection for some of the auxiliary vessels recently purchased. The inventor is a member of the engineer corps of the U. S. Revenue Cutter Service.



SECTION OF MCALLISTER SYSTEM BUILT-UP OIL-TEMPERED NICKEL STEEL ARMOR PLATE.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.
S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representatives.
L. L. CLINE, Detroit, Mich., 47 Hodges Building.
B. M. GARDNER, Chicago, Ill., 1142 Monadnock Block.

Traveling Representatives.
E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:
Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

IT would be interesting to know the present opinion of those members of Congress who in the past have blocked the way of naval progress, supposing, of course, they have acted from conviction. To prepare ourselves for war with a fifth-rate naval power we have been compelled to scour the shipyards of Europe for naval vessels, and to be content, at that, with a few comparatively insignificant ships. Of these, two, at least, will not be of the slighest practical value during the period of hostilities, as the "Abrouill" and "Somers" will not be allowed to sail from the English ports where they are now lving. The previous apathy of Congress has also forced the Navy Department to the necessity of purchasing, and placing in commission, numerous small vessels, for offensive purposes, which were never intended in design or construction for such use. Should any serious loss of life result from the employment of these necessarily inefficient vessels the responsibility will rest entirely with these members of the House and Senate. With talk of "entangling alliances" on the one hand and pretended economy on the other, they have declined to vote the money necessary for the construction and proper equipment of a navy, commensurate with the importance of the foreign interests of the United States. It has thus come about that many unthinking persons blame the officials of the Navy for our unreadiness, when there is no ground whatever for a word of censure here. In the various departments of the Navy there are to-day as thoroughly informed and capable men as can be found in any navy in the world. Without appropriations, their knowledge and ideas cannot be productive of results. There is no profit in worrying about the past, however, if it is an example that is profited by. In the passage of the Naval Appropriation bill, with additions by the Senate, as recounted elsewhere, there are signs of faint appreciation of the present requirements. No advance has yet been made with the proposition to speedily construct a number of torpedo boats, a measure which has the hearty support of Chief Constructor Philip Hichborn and Engineer-in-Chief George W. Melville. Had the bill been pushed through Congress, work would even now be pretty far forward on the boats, and the contracts would have the splendid effect of raising the standard of workmanship in many of the yards which would likely get orders. Now the greatest need of the Navy is capable engineers, and, indeed, the negligence of Congress in this direction has allowed our fleets to be confronted with possible disaster. It is a solemn fact that there are not enough Regular Engineer Officers in the Navy to-day to efficiently officer our ships *in time of peace*. The condition is not new, as for ten years past Engineer-in-Chief George W. Melville has warned the country of the consequences of having an insufficient number of officers in the engineering branch of the service. Under the emergency law, which we note elsewhere, the Navy Department is now given the power to appoint from civil life a number of commissioned and warrant engineer officers in the Navy, who are to have relative rank not exceeding that of lieutenant. They shall serve "only during the continuance of the exigency under which their services are required." Engineers can now file their applications, and, temporarily at least, the difficulty will be bridged over. It will be a splendid opportunity to select a number of men for permanent duty in the Engineer Corps of the Navy.

NO recent action of Congress was more gratifying to all persons interested in marine work than the appropriation of $330,000 to pay a rightful claim on the Government to the heirs of John Roach. This claim was for compensation for the use of the Roach shops, at Chester

and New York, by the Government, for a period of twenty months, while finishing the cruisers Atlanta, Boston and Chicago. The story of the dealings between the Government and John Roach, when the first ships of the original White Squadron were built, is familiar history. The contract awarded the late Mr. Roach by the Arthur Administration for the construction of the naval vessels Dolphin, Atlanta, Boston and Chicago called for the completion of all four within eighteen months. This time limit was almost a guess, for there was no precedent by which an accurate estimate could have been made. The builder had so much confidence, however, in his great skill that he willingly accepted the conditions. As it turned out, he was unable to comply with this clause. Other complications ensued. A new Administration had come into office and very promptly showed an unfriendly spirit toward the Roach yard. The Dolphin was condemned as structurally weak, and one of the legal advisers of the Government construed the Roach contracts in such a way as to leave no alternative for Mr. Roach but an assignment. Following this came the occupation of his shops by the Government, which took twenty months to complete vessels already in an advanced stage of construction; vessels which its predecessors in office had decided could be built outright in eighteen months. John Roach did not long survive this harsh treatment, and went to an untimely grave, done to death by political intrigue that took no account of his long and splendid services to his country in helping to build up its merchant marine. A monetary compensation is no offset to an injustice which the pages of our naval history will ever record, but it is a substantial evidence of recognition of that wrong.

AN announcement appears in the daily press that Theodore Roosevelt, Assistant Secretary of the Navy, has resigned, with the intention of raising a regiment of rough riders, to join the auxiliary forces for operations in Cuba. The Army's gain will be the Navy's loss. It would seem, indeed, as though the gain to the army of occupation would not counterbalance the loss to the forces on sea. The patriotism and courage which Mr. Roosevelt has, and which neither compliment nor criticism can affect, are surely more needed in these serious times in the counsels at Washington than in the thickets of Cuba. It is hardly open to dispute that the successful leadership of a body of irregular horse calls for lower intellectual qualities than the Assistant Secretaryship of the Navy, with a seat on the Board of Strategy. There are many frontiersmen qualified for the former, and exceedingly few from town or country who could fulfil the duties of the latter, without risk of blunder, if not disaster. Mr. Roosevelt's connection with the Navy has been an inspiration. Intellectual, vigorous, just, with capability, not only for great problems but little details, with a proper perspective of inflexible formulæ and precedent, without naval prejudices, and ever with singleheartedness for the nation's good, he is close to the ideal. For a man of his spirit to live in safety at Washington would call for a greater sacrifice than to be in the vanguard in battle; but such service the country needs. We sincerely hope that Mr. Roosevelt may be reasoned into an abandonment of his plans to go to the front.

AS illustrating the difficulty of securing accurate information at long range concerning the equipment of vessels, the case of U. S. S. New Orleans is in point. The original plans of this vessel, which were reproduced in the April issue, show the four 6-inch main battery guns twin-mounted as bow and stern chasers. Upon the arrival of the cruiser in New York we found that a rearrangement of her batteries had been made, and that the bow and stern 6-inch guns were mounted singly. The other two 6-inch guns are in the waist with broadside discharge. Before the arrival of the vessel here there was some doubt about the type of boilers she carries, which were supposed to be Bellevilles. They are of the Scotch type. The engines are by the English engineers, Messrs. Humphrys, Tennant and Company, Deptford, London. Coming across, the engine room staff of the New Orleans had many laughable experiences in translating the various instructions on the signals, valves and handling gear, which were all in Spanish.

REGARDING the recent breakage of the starboard outboard shaft of the American liner Paris, while bound east, which was noted in our April issue, we are informed upon the authority of Mr. James S. Doran, Superintending Engineer of the line, that the shaft was not made of nickel steel, but was of the highest grade of material for the purpose, made by Messrs. Vickers, of Sheffield, England.

CORRESPONDENCE.

[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Comment on Phenomenon in Propeller Blades.

In your April issue I noticed an article by W. S. Smith, U. S. N., in which he says that on the propellers of several Atlantic liners the following edges of the bronze blades were slightly bent or curled for several inches, and he expresses surprise that this bend projected aft from the driving faces. He apparently does not believe that the change of shape was due to the blades coming in contact with an unyielding substance when going astern, but looks elsewhere for an explanation. The phenomenon, I believe, can be explained thus: Any distortion of a blade would naturally be noted at the dry docking of a ship, and if the same were excessive, the blade would be condemned as being too weak. This is of very rare occurrence, as nearly all blades in use always present the same appearance, as far as pitch and overhang are concerned, at each succeeding examination, leaving accidents, corrosion, etc., out of the question. The shape the blades assume when working under full power, however, is unknown. It is natural to suppose that they bend forward at the tip, and the thrust also tends to diminish the angles of the surface, or, in other words, to reduce the pitch, as stated in Durand's new book, "Resistance and Propulsion of Ships." The statement, no doubt, is true, as, with few exceptions, in all high powered fast running vessels the slip is greater than usual.

Let us now consider the effect of this reduction in pitch or twisting action on the material of the blade. The twisting takes place around an axis passing through the center of the hub and the center of the section at the root; and if the blade is symmetrical this axis will pass through the center. The strain due to the twisting action will be nil at the axis and greatest at the edges, where it will be in the nature of a tensile strain in the direction of the length of the edge. The combined bending and twisting strain will not be as serious in a symmetrical vertical blade as it will be in a blade that has athwartship overhang. In the latter case the axis will come close to the leading edge which will consequently receive very little strain, while the following edge will be the farthest away from the axis and there the strain will be the greatest; and if there is not enough material at this edge, the material will stretch beyond its elastic limit and will be reduced in area, but retain the sharp edge. When the engine stops and the blade comes to rest it will again assume its normal shape, with the exception of the following edge, which, having been pulled beyond its elastic limit will now be compressed. This compression will not compel the material to flow out to its former position again, but will compel it to curl aft due to the twisting action. As the blade section near the root is heavy, and the surface near the tip approximates a plane surface it is evident that the greatest amount of stretching of the edge will take place about half way between these points.

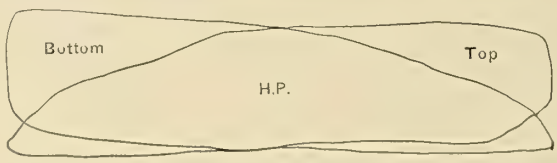
Most of the large blades nowadays are built so that the backing surface of every section is the arc of a circle, and consequently the blade is thickest at the center line of its width. There are some older types of blades with large overhang in which the thickest part of their sections is nearest to the following edge at a distance of about one-quarter the width of the blade. The object of this was to reduce the angle of entrance of the backing side, but it is a question whether the coarse angle of leaving would not nullify all the advantage gained.

According to the above reasoning this form of blade ought to be stiffer and give less slip, at the same time it would not be any heavier and the heavier section near the following edge would not curl.

NEWPORT NEWS.

Query About Indicator Card.

I enclose you a card taken from the H.P. engine of our steamer. There is a defect which I wish some of your readers would explain to me. I know of three sets of engines built by the same builder that show identically the same defect. Why does the top corner round off instead of being square? Raising the



valve does not make any change in that point of the card. Particulars are: Engines, triple expansion; cylinder, 22 in. dia. and 28 in. stroke; revolutions, 102; boiler pressure, 128 lbs.; spring, 80 lbs.; travel of valve, 5 1-4 in.; valve, 15 in. dia.; cutoff, 2 in. (?) valve takes steam in center; lead, top and bottom, 1-16 in. I should like to hear from some card experts.

POTOMAC.

In Explanation of Walschaert Valve Gear.

This valve gear is a modification of the gear which has been described in many works on the subject under the name of Heusinger von Waldegg. Referring to the diagram on page 34 of the November, 1897, issue of Marine Engineering, a part of which is here reproduced in Fig. 1, the only change necessary to bring it to the original Heusinger motion would be to replace the link A C, connecting the valve lever A F with the crosshead, by a pivoted socket attached to the crosshead, through which the valve lever slipped as it was driven back and forth. The change simply amounted to replacing one method of connection by, what is in this case, a better mechanical device.

The movement of the valve for a given movement of the piston can only be approximated by any method of analysis, but even such an approximation is of value to the designer. It is to be remembered that the simpler valve diagrams give only the relative movement of a valve and the crank, and not of the valve and piston, it being assumed that it is convenient to locate the piston position from the crank position. With a gear of this kind the piston position is an essential point in determining the movement of the valve.

To determine the movement of the valve for any movement of the piston, let us take the Zeuner diagram for a basis and see just what it means. In Fig. 2 let O A be the crank, O B the eccentric and B C the eccentric rod, assumed here to be so long that the movement of C along O C is the same as the horizontal movement of B. Let O D represent the center of the movement of B, and lay off O E so that D O E is equal to B O A. O E will now be the position of the crank when the point C is in its middle position. O F at right angles to O E will be the crank position corresponding to the greatest distance that C has traveled to the right. If on O F we draw a circle passing through O, with O B as a diameter, we will have a Zeuner diagram showing the movement of the point C with relation to the movement of the crank O A.

In the Walschaert gear, as represented in Fig. 1, the valve obtains its movement partly from the crank and partly from the eccentric. Applying the above construction to that figure, the movement obtained from the crank itself would be represented by the

circle O B of Fig. 3, as the crank has its greatest effect on the valve when it is on one of the dead points, while that obtained from the eccentric would be represented by O A, as the eccentric has its greatest effect when the crank has moved 90 degrees from

To determine the value of this movement on the valve. The movement which is transmitted to the valve from the crosshead is the movement of the crosshead times $\frac{D F}{A D}$, Fig. 1. Or, if R is the radius of

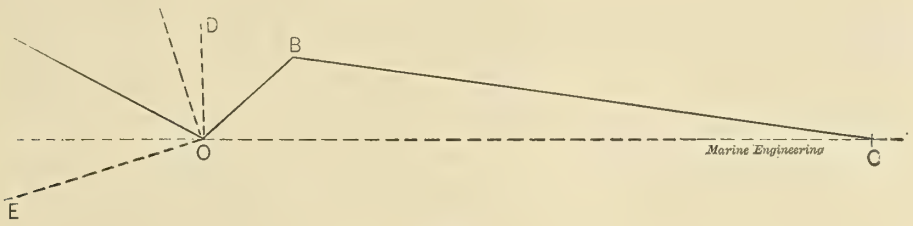


Fig. 2.

the dead point. That is, if the crank is at any position O D, the valve would be in this case a distance O E below its middle position, due to the movement of the crank, and below it an additional distance O F, due to the movement of the eccentric, the actual resulting movement of the valve being such that the valve is O E + O F or O D below its middle position. This combined movement will be a circle passing through B, O and A, and will be the Zeuner diagram for the gear.

It has been assumed that the rod B C of Fig. 2 is long in proportion to O B. In the case of the eccentric rod this is generally the case, in the case of the

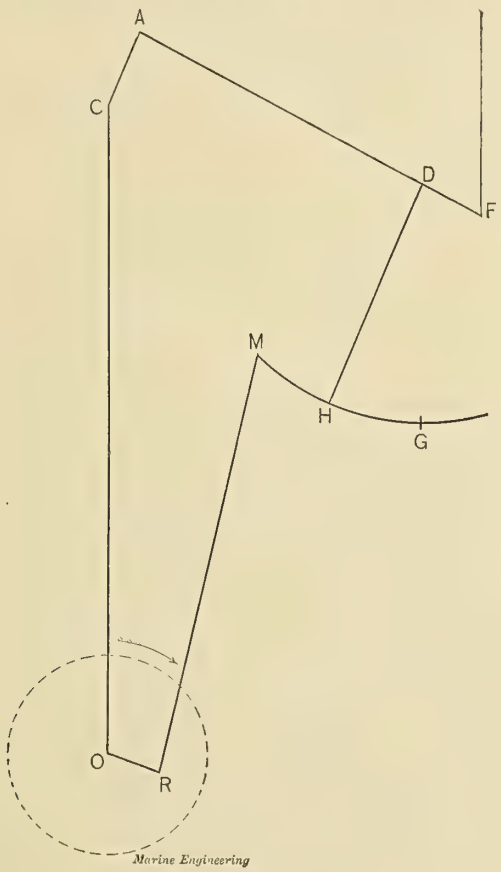


Fig. 1.

connecting rod it may not be. First considering the case where these rods are both long, the circle of the last figure represents closely enough the character of the movement transmitted to the ends of the eccentric or connecting rod.

the crank, R $\times \frac{D F}{A D}$ is the diameter of the circle O B of Fig. 3.

The movement obtained from the eccentric is transmitted to the valve through the lever M G pivoted at G and A F pivoted at A, Fig. 1, as far as this movement is concerned. The movement of H is less than that of M in the ratio $\frac{H G}{M G}$ and the movement of F is greater than that of D, or of H, in the proportion of $\frac{A F}{A D}$. The movement that the valve obtains from the eccentric, calling r the throw of the eccentric, is $r \times \frac{H G}{M G} \times \frac{A F}{A D}$. This gives us the diameter of the circle O A of Fig. 3.

The resulting travel of the valve can then be obtained either one point at a time, or by drawing a third circle through O, B and A, as shown in Fig. 3.

This gives us the usual Zeuner diagram and by drawing the lap circles, etc., the different points relating to cut-off, exhaust, etc., can be determined.

When, as in the case of marine engines, the connecting rod is short in proportion to the crank throw the circle O B of Fig. 3 is not even a close approxima-

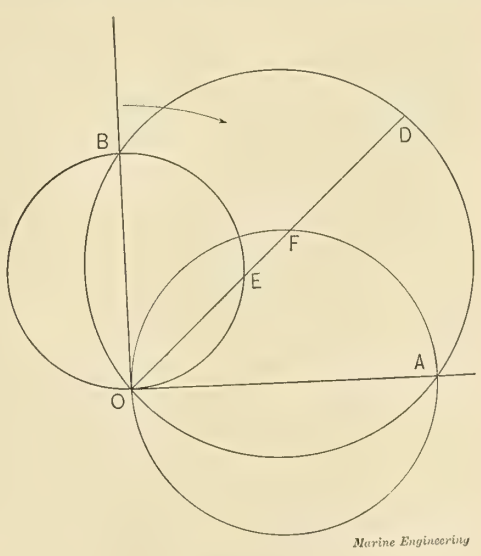


Fig. 3.

tion to the valve movement. The curve is no longer a circle, but can be found as shown in Fig. 4. In this figure O B is the same circle as in Fig. 3. O D is a circle having a diameter greater than O B in the proportion of O B to B C of Fig. 2, or as the connecting

rod is to the crank. To determine the movement of the valve for any position O F of the crank, draw O G so that the angle G O H is equal to F O D. Make O J equal to O I and D K equal to D J. Then O K is the correction to be subtracted from O F if the crank and connecting rod occupy the position shown in Fig. 2, and to be added when the angle between the two is an acute angle.

Fig. 5 shows these corrections made for crank and connecting rod values of 4 to 1, the broken line be-

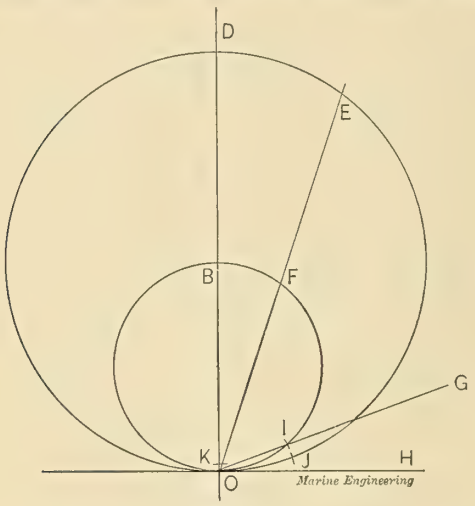


FIG. 4.

ing the circle O B of Figs. 3 and 4 and the full line the corrected diagram. The resulting valve diagram must be determined point by point. While this construction allows for the angularity of the connecting rod, there are so many other rods having similar effects on the valve diagram that it is still only an approximation and usually the dimensions obtained from the first diagram—that of Fig. 3—is a close enough approximate to begin with.

In designing a gear of this kind the ratio in which the lever A F, Fig. 1, is divided is the ratio of the lap plus the lead to the radius of the crank.

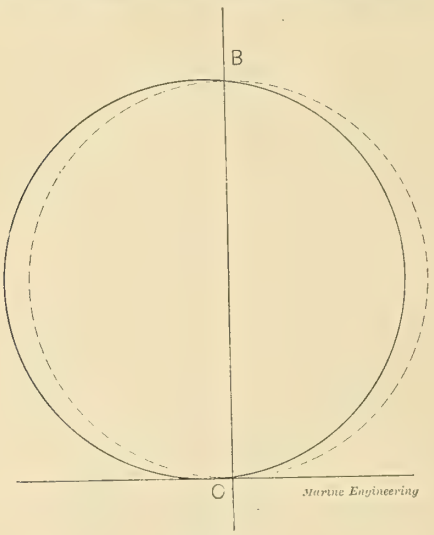


FIG. 5.

A trial value of the throw of the eccentric can be obtained by drawing the valve diagram for the maximum point of cut-off, as shown in Fig. 6. Lay off A C the lap and C B the lead. Let A D be the crank position corresponding to the point of greatest cut-off. Lay off A E equal to the lap and draw a circle through A, B and E. The distance A K is then the diameter of the circle O A of Fig. 3. This distance is the eccentric throw times $\frac{H\,G}{G\,M} \times \frac{A\,F}{A\,D}$ of Fig. 1. If, for the maximum cut-off, H can move as far out as M, the value A K is the eccentric throw times $\frac{A\,F}{A\,D}$. If, however, it can only move out so that H G is, say, .8 G M, the value of the throw is $1 \div .8$, as much.

The use of this gear for marine work is not likely to greatly increase. It is used on quite a number of foreign locomotives and has been tried in this country, and it has been found that it has no advantages over an ordinary link. It is more difficult to adjust, is quite as expensive, and is more affected by wear.

We are entirely in accord with Prof. C. H. Peabody as to the value of a model for determining the exact movement of the valve for a given engine—*if the gear is already designed.* A Zeuner diagram is, however, of value to the designer of such a gear in that it enables him to determine the value of many of

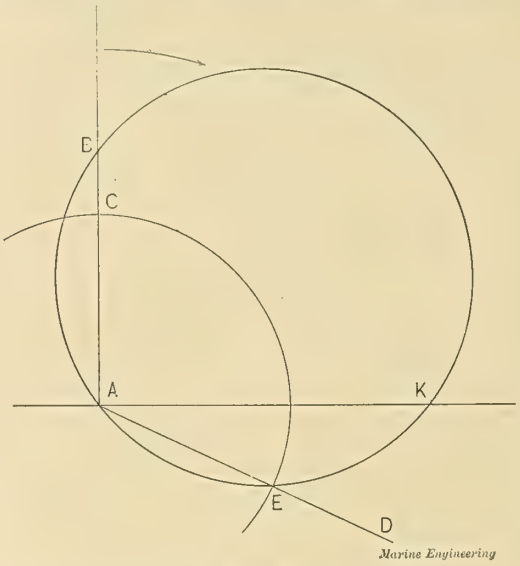


FIG. 6.

those proportions of the gear which, as Professor Peabody says, "are imposed upon the diagram by the general construction of the engine," and which must be known before a model can be constructed.

The Zeuner diagram is of considerable value in connection with a model, as it gives a clue to the direction in which changes in dimensions should be made to produce desired results.

C. R. STEWART.
H. W. SPANGLER.

Tail Shaft Breakages.

Many breakages of tail shafts of ocean steamers are due to the galvanic action caused by the contact of bronze and steel in the presence of sea water. I should like to hear from other correspondents regarding experiments that have been made with the object of ascertaining what composition of bronze will cause the least amount of galvanic action. White metal sleeves, having a minimum amount of copper in their composition, are said to cause very little galvanic action on the steel of the shaft, and that the action takes place on the sleeve itself. I understand that copper is electro-negative to steel, while zinc is electro-positive, and therefore the galvanic action affects either the shaft or the sleeve according to the preponderance of the copper or zinc in the sleeve. P.

EDUCATIONAL.

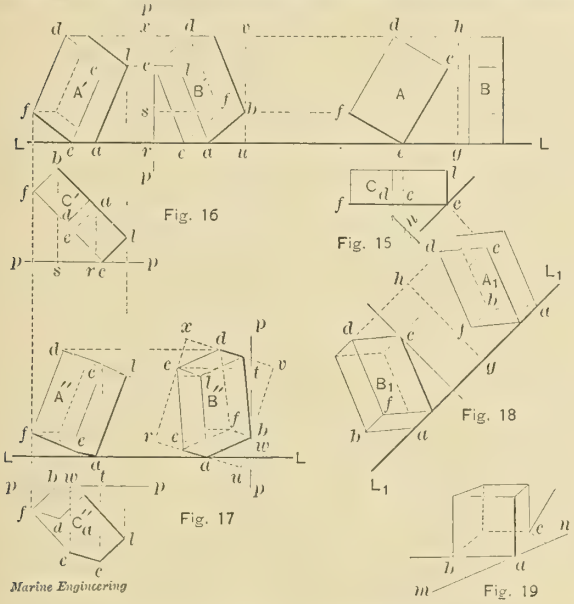
THE ART OF MAKING MECHANICAL SKETCHES —FOR MARINE ENGINEERS.—IV.

BY PROF. C. W. MACCORD.

In the preceding article an explanation was given of the method of determining, from the projections of a prism in its simplest position in relation to the paper, the correct representations of the same object in three other positions, each of which was derived from the original one, by revolving the prism about one or the other of its three adjacent edges.

Each of these axes is perpendicular to the paper in one of the three views, where it appears as a point, and neither the from nor the dimensions of that view are changed by rotation about it; and we have seen that in the other two views one set of dimensions is also unchanged. Clearly these things are true, whether the original object be a prism, or anything else; and even if it be one, it need not be placed in the simplest position in order to revolve it about either axis. We now proceed to consider the results of performing these rotations consecutively.

In Fig. 15 the prism is represented in the same position as in Fig. 11—the top view for convenience being placed below the front view, in which one rotation



FIGS. 15, 16, 17, 18, and 19.

has already been performed. Let us next turn it about a vertical axis—that is, one perpendicular to the paper in the top view C; since this remains unchanged, it is in Fig. 16 simply copied in its new position C′. Now in the front view A′, each point must be vertically over the position of the same point in the top view; and its distance above L L is the same as in Fig. 15, since each point in revolving about a vertical axis must move in a horizontal plane—in other words the heights are unchanged, as explained in connection with Fig 13.

Next, imagine a vertical reference plane *p p*, for convenience passing through the nearest point *c* in the top view; this will also be seen edgewise as the vertical line *p p* in the side view B′. In constructing this view it is only necessary to keep in mind that the height of each point is the same as in the front view, and its distance from *p p* the same as in the top view; for instance, *c* lies in the reference plane, and *a r*, *b s*, are the same in B′ as in C′.

It remains now to rotate the prism about the third axis, that is, one perpendicular to the paper in the side view. This will affect neither the form nor the dimensions of B′, which in Fig. 17 is accordingly copied in a new position as B″.

The simplest and best method of making this copy is this: Complete in Fig 16 the rectangle *r u v x* within which B′ is inscribed, and draw this first in Fig. 17 at the proposed inclination, and on its sides set off the distances *r a*, *r e*, *r c*, *v d*, *v b*, etc., as measured on Fig. 16. This simply amounts to constructing the various angles, acute and obtuse, by means of offsets instead of by means of arcs; but it is by far less laborious and much more reliable.

As was shown in connection with Fig. 12, the *breadths*, or distances from right to left, in the other two views, are not affected by this rotation, and will therefore be the same as in Fig 16. In constructing the froint view A″, then, the points *f*, *d*, *l*, etc., will appear directly under the positions of the corresponding points in A′; their distances above L L being of course the same as in B″.

The top view C″ is constructed from the other two, in a manner precisely similar to that used in Fig. 12; a vertical reference plane *p p* in the side view will appear in the top view as *p p* parallel to L L, and the distances of the various points from this plane are the same in C″ and in B″. The position of such a reference plane is arbitrary—in this case it passes through the point *b* on the extreme right in the side view, which is therefore the most remote point in the top view; other points as *c*, *e*, etc., will appear directly under the corresponding points in A″, the distances *c t*, *e w*, etc., being the same as in the side view.

We have now reached the most complicated position in which the prism can be placed in relation to the paper; none of the lines is shown in its true length, nor does any angle appear as a right angle in any one of the views. Consequently no one of the faces appears as a rectangle, but, recollecting that all lines which are parallel in space will appear parallel in any projection, and also equally foreshortened, we perceive that every face will appear as a *parallelogram*, with its opposite sides equal and parallel to each other. If this be kept always in mind it will be found not only an excellent check upon the accuracy of the work, but of the greatest service in facilitating the construction.

Since the three adjacent edges of the prism in its original position represent length, breadth and thickness, the only three dimensions in space, it is clear that by successive rotations about them, as above described, the object can be brought into any possible position in relation to the paper; and it is not possible to represent it correctly in the final position of Fig. 17, or in the intermediate positions of Figs. 15 and 16, without performing these revolutions, either actually or virtually. It is, of course, to be understood that these special positions are merely selected for illustration; the directions as well as the angles of rotation are entirely arbitrary, and the order of succession of the axes about which the rotations are made is also a matter of indifference.

It was mentioned in the foregoing that these rotations must be made either actually or *virtually*: in passing from the position of Fig. 15 to that of Fig. 16, it is not necessary to *copy* C in the new position C′, which represents it after turning through a given angle in a certain direction. Instead of this, let the observer move through the same angle in the opposite direction so as to look horizontally toward C, as shown by the arrow *n*; then, as explained in connection with Fig. 14, the horizontal plane will appear as the line L_1 L_1 perpendicular to *n*. In constructing the view A_1, each point is projected perpendicularly toward L_1 L_1, and its distance above that line is the same as its distance above L L in Fig. 15—as for instance *g h*, which measures the height of the upper edge.

B_1, in Fig. 18, is a view of A_1 from the left, and the distances of the various points from a reference

plane through *c* are taken by measurement from C just as they were from C′ in Fig. 16. This done, it is clear that C is a top view not only of A in Fig. 15, but also of A_1 in Fig. 18.

The labor involved in passing from the original position of the prism to that given in Fig. 17, by the above process, is so great the writer was led some six years ago to seek for some means of dispensing with a portion of it. This he succeeded in finding, by availing himself of the following principle, viz.: That simultaneous rotations about two intersecting axes are equivalent to a single rotation about a third axis lying in the plane of the other two, and passing through their point of intersection. Thus in Fig. 19, a rotation about *a c* will raise *b* above the plane *b c*, and a rotation about *a b* will produce the same effect upon *c*; while a rotation about *m a n* will do both things at once. The height to which *b* and *c* will be raised above their original positions, will evidently be directly proportional to their distances from the axis; by properly proportioning these distances, then, those two points can be raised to any given height: and since *a* remains fixed, the inclination of the plane *b c* to its original position will thus be determined. This done, the prism can be placed in any conceivable position by rotating it about a vertical axis passing through *a*.

The application of this is shown in Fig. 20, where A, B, C represent the prism in its simplest position. Let *m n*, lying in the horizontal plane L L, and passing through the corner *c*, be the axis about which it is

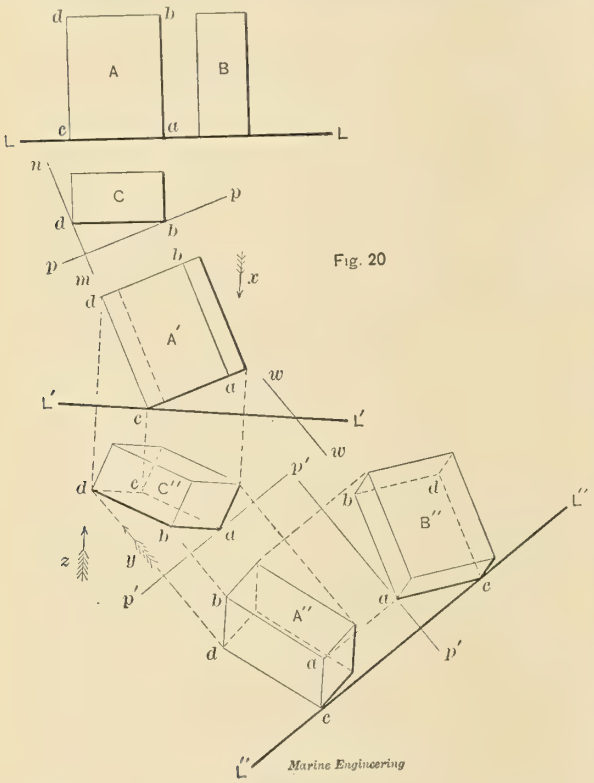


Fig. 20.

first to be revolved; then the first step is to construct the front view A′, looking in the direction *m n*—which is done precisely as in Fig. 14.

Supposing the angle of rotation to be assigned, draw L′ *c* L′, making that angle with the plane of the base, *c a*, then L′ L′ will represent the horizontal plane in its new position with reference to the prism.

The next step is draw a top view of A′, looking down upon it in a direction perpendicular to L′ L′, as shown by arrow *x*. In constructing this, we draw a reference plane *p p*, perpendicular to *m n* through the corner *b* of the original top view C. This obviously contains the vertical edge *b a* of the prism; consequently this edge will be parallel to L′ L′, and so will all the other edges which were originally vertical, while their distances above *a b* in the new top view C″ will be the same as their distances from *p p* in the original one.

Now A is a front view of C″, seen in the direction of the arrow *z*; supposing it to be finally required to rotate the prism about a vertical axis through a given angle in one direction, then instead of copying C″ in the new position which would be thus determined (as was done in Fig. 16), we move around through the same angle in the opposite direction (as in the construction of Fig. 18); which determines the direction of the arrow *y*, for the construction of the final front view A″. In this view the horizontal plane appears as L″ L″ perpendicular to *y*; all the points of C″ are projected perpendicular toward it, their distances above it being equal to their distances above L′ L′ in the view A. And from A″ and C″ the side view B″ is laid out by means of the reference plane *p′ p′* exactly as in Figs. 16 and 18.

We have, then, that between the simplest and the most complex position, but one intermediate view A′, and that very easily constructed, is required; the problem is thus reduced to its very lowest terms, *and the labor involved is reduced to a minimum.*

In practice it would often be necessary to have the arrangement such that the base line L″ L′ should be horizontal upon the paper. And usually there would be no reason for preserving a record of the process of construction, and consequently no necessity of inking in the intermediate view A′. Nor need it be even penciled upon the finished sheet—it may be drawn, in connection with the top view C, upon a piece of tracing paper; then drawing a line *w w* parallel to the arrow *y*, the tracing paper may be pinned down over the sheet, taking care to adjust it so as to make *w w* vertical. Then the view C″ may be constructed upon the sheet below the edge of the tracing paper, which is to be finally removed.

It has been preferred to adhere throughout these explanations to the simple prism as the object to be represented: the manipulations by which the final position is reached, and even the processes of constructing the third view by means of the other two, are apt to be quite perplexing to a beginner, even in dealing with so simple a subject as that; and it will be found that the study of a model—say a block of wood, which can be placed in the various positions and examined at leisure, will be of great assistance to those who at first find difficulty in *reading* the drawings, that is, in forming a clear mental picture of just how the object appears in space, by the aid of the representations alone.

The principles and the methods, however, are perfectly general, and those above set forth are all that are required in drawing the most complex objects.

In Fig. 21 is shown a very simple exercise, the object being a hexagonal pyramid, with one face lying in the horizontal plane. At the right, is a view looking perpendicularly against the plane of the base, which is therefore seen in its true size and form. The circle circumscribing the base is first drawn, and the hexagon laid out within it—supposing, that is, that the inclination of the axis is assigned.

The point *f* in this end view is then projected back to *f* in the horizontal plane in the front view, and the base *f b* then drawn perpendicular to the axis. The rest of the construction should require no explanation; but attention is called to the fact that the points *a*, *b*, *c*, etc., in the top view, must be points in the curve which is the foreshortened representation of the circle in the plane of the base.

Had the base of the pyramid been a polygon of twelve sides, the construction of the drawing would have been just as simple as it is now. Then, however,

there would have been twice as many points located in the foreshortened view, and the curve would have been more accurately defined. This leads to the consideration that the inclined projection of a circle might be made by merely finding the projections of any desired number of points in it. The same would of course be true of a curve of any other form. In-

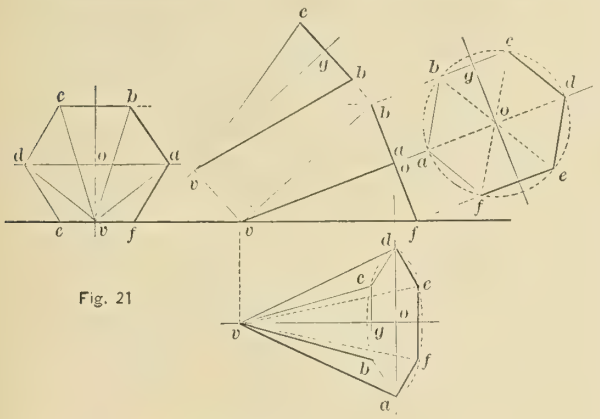


Fig. 21

Fig. 21.

deed in the case of irregular curves, or those of unknown properties, that is the only method practicable. But the inclined view of a circle being an ellipse, the work may often be simplified by making use of known properties of that curve. Such views are so often required as to call for a more extended examination of this matter, which is reserved for a subsequent article.

QUERIES AND ANSWERS.

Q. I expect to take my examination soon for a certificate, and I am a little uncertain about the matter of staying boilers. I am told you have to figure on these to pass the examination and I wish you could give me some pointers. BRACES.

A.—As a general rule, all flat surfaces in a boiler require some support in addition to that which can be furnished by their own strength. This depends, of course, on the size and thickness of the surface in question. If small enough in relation to its thickness and the steam pressure per square inch it will be strong enough without any stay or support. In fact the whole idea of bracing is to subdivide by the braces a large

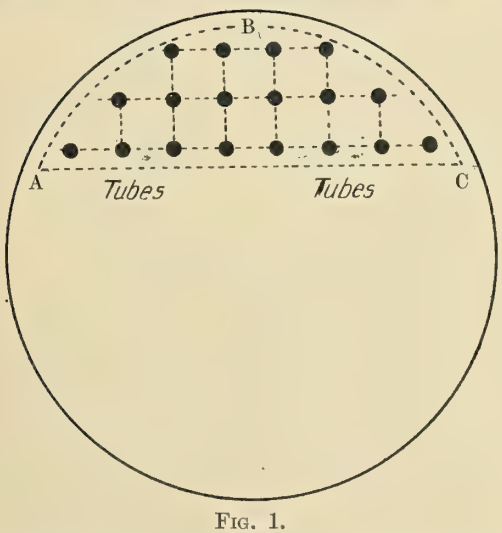


Fig. 1.

flat surface into a sufficient number of smaller surfaces, each of which shall be self supporting between the points where the braces are connected to the plate. The braces are then designed so as to be able to carry the entire load as a whole, and the parts of the plate between the braces are simply required to support, without change of shape, the part of the load which comes upon them.

To illustrate this plainly by a diagram, let Fig. 1 represent a part of a boiler head requiring bracing. Now imagine the plate entirely cut out around the dotted line A B C, and then fitted in so exactly as to make a steam tight joint. The part A B C is therefore entirely cut off from the remainder of the head, and without some special support would be blown out right away when steam was raised. Now suppose the braces to be so designed that they may be safely depended on to carry the entire load on the plate and thus keep it securely in place in the head. It simply remains then for the parts of the plate between the braces to support themselves without losing their proper shape, and the support is thus made complete. In the actual boiler head or in all similar cases where a flat surface has to resist pressure the design of the braces is worked out exactly upon these lines, and no account is taken of the strength of the plate for the general support of the load as a whole.

In designing boiler braces we have to consider two things: (1) The total load to be supported and the number of braces, or simply the load upon one brace as determined by their spacing and the steam pressure. (2) The safe load per square inch of section of brace. The total load depends on the area and the gauge pressure. In figuring out the area as in Fig. 1, it is usual to consider that a narrow ring of metal around the outside (the circumference) of the head will be well supported by the shell, and also by the tubes. The width of such band is usually taken as two or three inches, though there seems to be no good reason why it should not be taken as half the spacing or pitch of the braces. This is the same as considering the shell and tubes as effective braces or supports for that part of the plate near them, in the same manner and to the same extent as for the braces themselves. The area thus found is then multiplied by the gauge pressure, and the total load is found. In regard to the number and spacing of the braces it should be remembered that the thinner the plate the closer the spacing, and the contrary is also true. Also that a plate exposed to the hot gas, flame or fire on one side should have its braces more closely spaced than for a plate not so exposed. Thus, for example, you will have noticed the

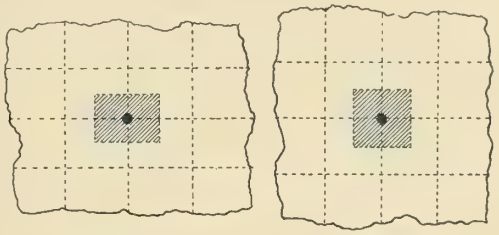


Fig. 3. Fig. 2.

screw stay-bolts for fire boxes and combustion chambers 3-8 in. to 5-8 in. thick are usually spaced from 5 in. to 8 in. between centers, 7 in. being common in large Scotch boilers. According to the U. S. rules, the greatest spacing allowed for any plate of this kind is 10 1-2 in. On the other hand, the braces for the head in the steam space are usually spaced as widely apart as 12 in. to 16 in., the latter being the greatest spacing allowed under U. S. rules. While braces are considered as supporting the plate at certain *points*, it must not be forgotten that when fitted with washers and nuts, as is common with the head braces of marine boilers, the area really supported in a direct manner is a circle 5 in. to 8 in. in diameter, and thus the area of plate between the braces is correspondingly reduced. The rules giving the proper relations betwen *pitch of braces, thickness of plate*, and *steam pressure* you will find in the "Rules of the Board of Supervising Inspectors of Steam Vessels." The present answer is, of course, concerned with the *braces* rather than with the *plates*, and this reference alone is made to the rules especially relating to the *plates*. The total load and the number of braces having been ascertained, the load on each brace is found by dividing the total load by the number. Otherwise, if the spacing is known the load on each brace is immediately found by multiplying the area which it supports by the pressure per square inch. Thus in Fig. 2 the surface supported by the brace is considered as the shaded portion, and the spacing being the same both ways, its area is the square of the pitch. In some cases the spacing is not the same in both directions, as in Fig. 3. In such case the supported area is found by multiplying together the two pitches. Thus in Fig. 2 let the side of the square be 7 in.; then the supported area is 49 sq. in. Likewise in Fig. 3 let the pitch be 14 in. in one direction and 16 in. in the other. Then the supported area equals the product of 14 in. by 16 in., or 224 square inches.

If the brace is oblique to the plate, as in Fig. 4, the load coming upon it will be greater than if square. The amount of this increase is figured in this way: Let A C be the brace inclined to the plate as shown. Let B be any point on the brace, and draw B D square to the plate. Then the increase is in the same proportion that A B is greater than D B. That is to say:

Load on brace A C : Load if brace were square : : A B : D B.

This may be found by laying down the brace on drawing paper and measuring the lengths A B and D B, or it may be figured thus: Let the slope be 1 in. to the foot. Then if A B

$= 12$ in. A D $= 1$ in. and D B $= \sqrt{12^2 - 1^2} = \sqrt{144 - 1}$ $= \sqrt{143} = 11.96$. Then the increase is in the ratio $\frac{12}{11.96} =$ 1.0033 or about one-third of one per cent. As you will perceive from this example, the increase is quite small for all inclinations usually met with in practical work.

With regard to the safe load for braces the U. S. rules provide that iron braces shall not be allowed more than 6,000 lbs. per square inch of section; while for steel, if inspected according to regulation, the allowance may be as follows: From

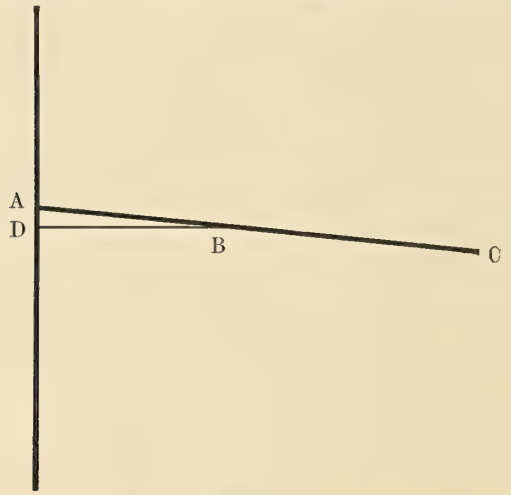


FIG. 4.

1 1-4 in. dia. to 2 1-2 dia., not to exceed 8,000 lbs., and above 2 1-2 in. dia., not to exceed 9,000 lbs., each per square inch of section. It must be carefully noted that in all cases the diameter is measured at the bottom of the screw thread, or at the smallest section. For this reason the screw threads are usually *raised* so that the diameter at the bottom is not less than that of the body of the brace.

To make the foregoing perfectly plain a few simple examples will be of aid:

(1.) In Fig. 1 suppose the area A B C is found by measurement to be 3,784 sq. in., the steam pressure being 160 lbs. Find total load?

Ans. Load $= 3784 \times 160 = 605{,}440$ lbs.

(2.) Suppose we wish to fit 18 braces. Find the load on each one?

Ans. Load $3{,}784 \times 160 = 605{,}440$ lbs.

(2.) Suppose we wish to fit 18 braces. Find the load on each one?

Ans. Load $= 605{,}440 \div 18 = 33{,}636$.

(3.) Suppose instead that we wished to space the braces 14 in. between centers each way. Find load on each brace?

Ans. Load $= 14$ in. $\times 14$ in. $\times 160 = 196 \times 160 = 31{,}360$.

(4.) Suppose, instead, that the braces were to be spaced 14 in. one way and 16 in. the other. Find the load?

Ans. Load $= 14$ in. $\times 16$ in. $\times 160 = 35{,}840$ lbs.

(5.) Suppose we wish to space screw stay-bolts for the combustion chamber 6 in. $\times$ 6 in. Find the load?

Ans. Load $= 6$ in. $\times 6$ in. $\times 160 = 5{,}760$ lbs.

(6.) What would be the load in (5) if the spacing were 7 in. instead of 6 in?

Ans. Load $= 7$ in. $\times 7$ in. $\times 160 = 7{,}840$.

(7.) What would be the area and diameter of an iron brace in example (2)?

Ans. Area $= 33{,}636 \div 6{,}000 = 5.606$ sq. in. Corresponding diameter $= 2$ 11-16 in. nearly. Probably 2 3-4 in. would be used.

(8.) In example (3) what would be the area and diameter of a steel brace allowed 8,000 lbs. per sq. in. of section?

Ans. Area $= 31{,}360 \div 8{,}000 = 3.92$ sq. in. Corresponding diameter $= 2$ 1-4 in. nearly.

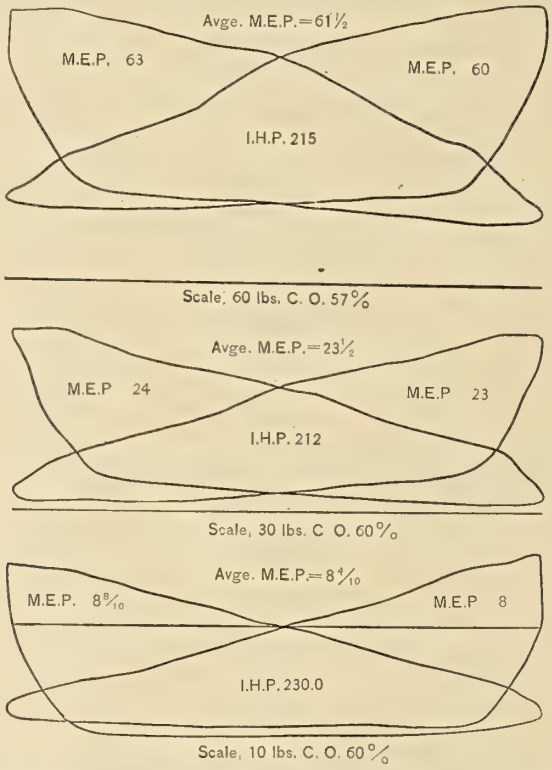
(9.) In example (6) what would be the area and diameter of a steel stay-bolt of the same allowed strength as in (8)?

Ans. Area $= 7{,}840 \div 8{,}000 = .98$ sq. in. Corresponding dia. $= 1$ 1-8 in. nearly.

Q. I inclose a set of indicator cards and will you please work out the indicated horse power, as I would like to see if it corresponds with the figures I have on them, and I would like any criticism. The engine is triple expansion, 19 in., 30.5 in., and 54 in. by 36 in. The boiler pressure is 160 lbs., vacuum 26 in., and engine speed 68 revolutions. TEXAS.

A.—From the general appearance of the cards they are evidently taken from an engine in which the high pressure crank moves to the top center in advance of the low pressure. They show a much earlier cutoff than is usual in engines of this type when running full out, and this in addition to the compression, which is excessive for 68 revolutions, would lead one to suppose that the engine was linked up when the cards were taken. The distribution of power is about as even as can be obtained in any triple-expansion job.

The admission line at the beginning of the stroke of the high pressure card shows a pressure of about 140 lbs., which is a drop of 20 lbs. from boiler pressure, and also shows a gradual drop in pressure to the point of cutoff, where it is only about 110 lbs., showing a loss of 50 lbs. pressure. This is due to the wire drawing of the steam in the steam pipe and valve chamber ports, and impairs the economy of the engine to a great extent. In good triple-expansion practice the difference between boiler pressure and the admission line ought not to exceed 5 lbs. with high-pressure steam, and the admission line ought to be parallel to the atmospheric line, or, in other



words, the steam ought to follow at full pressure up to the point of cutoff. Card (Fig. A) was taken from the high pressure cylinder of a large marine triple-expansion engine, and demonstrates what a good admission line ought to be. Many marine engines will show a drop in the high-pressure ad-

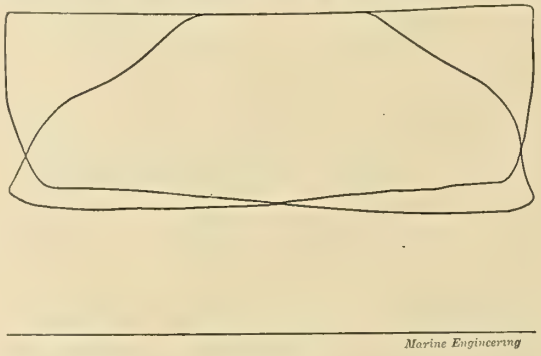


FIG. A.

mission line when they are linked up, owing to the reduced port opening, due to the decrease in the travel of the valve. The low pressure card shows a loss due to wire drawing at the exhaust port, as the engine realizes only 19 in. of the 26 in. of vacuum in the condenser. It ought to show 22 in. or 23 in. at least. The admission lines of the intermediate and low pressure cards are good, as in both cases they follow the exhaust line of their preceding cards, and show a loss of only 2 lbs. or 3 lbs. in the receivers. The early release in the high pressure and intermediate pressure cards is also a good point, as it tends to hold the receiver pressures more steady and prevents a heavy initial blow at admission in their following cylinders. The early release in the low pressure permits that cylinder to realize the vacuum much better than if it occurred at the end of the stroke.

The cards are well balanced top and bottom, and give evidence of careful valve adjustment.

ENGINEERS' DICTIONARY.—V.

Boiler Flue.—A large tube for the passage of gases. The difference between a *flue* and a *tube* is one of size only. Anything over about 6 in. dia. is usually termed a *flue*.

Boiler Hatch.—A hatchway or opening in the decks leading to the fire room, and usually appropriate in size for the passage of the boilers. See also *Boiler Trunk*.

Boiler Seating.—The seat or bed in which the boiler rests when installed in the ship. The usual form of seating consists of two or more steel plates on edge cut to the curvature of the boiler shell, and fitted with angles on the upper edge, as shown in section

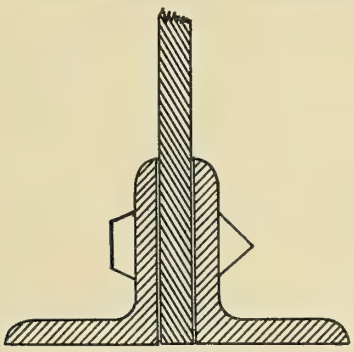


FIG. 12.

in Fig. 12. These plates are firmly secured to the structural members of the ship, and thus form a secure foundation for the weight they are to sustain.

Boiler Trunk.—A space leading from over the midship's part of the fire room to the upper deck, and bulkheaded off from the remainder of the ship. It contains the smoke-stacks and fire-room ventilators, and prevents the escape of hot air and dust to other parts of the ship.

Boiler Tube.—See **Boiler.** The material is usually wrought iron or steel, though brass and copper are occasionally used. Fire tubes are usually from 2 in. to 3 1-2 in. dia. In the small tube forms of water tube boilers, the diameter is usually from 1 in. to 2 in.,

FIG. 13.

while in the large tube varieties it may be from 4 in. to 5 in. The thickness varying with the size is usually from gauge number 14 to 6, or from about 1-12 in. to 1-5 in. Fire tubes are plain or of the *Serve* type, the cross section of which is shown in Fig. 13. Water tubes are always plain.

Boiling or *Ebullition.*—A term referring to the condition of a liquid when forming vapor with such rapidity that the escaping *globules* produce a continuous agitation throughout the body of the liquid.

DURING THE MONTH.

Contract was reported closed between the Old Dominion S. S. Co. and Roach's shipyard for the construction of two new vessels to replace the "Yorktown," sold to the Government, and the "Roanoke," sold for the Alaskan trade. The new vessels are to be upon the lines of the "Princess Anne," in dimensions about 324 ft. long; 42 ft. beam, and 27 ft. deep, fitted with triple expansion engines.

The launch of the Maine Steamship Co.'s new passenger coast liner, Horatio Hall, was successfully carried out at Roach's Shipyard. This fine addition to the company's fleet measures 320 ft. long, 46 ft. beam and 19 ft. 6 in. depth of hold. She will be fitted with triple-expansion engines, 28 in., 48 in. and 75 in., by 54 in. stroke, and with six Scotch boilers built for working pressure of about 180 lbs. Passenger accommodation is very modern and the vessel will have large cargo carrying capacity.

The organization of the Neafie & Levy Ship & Engine Building Co., Philadelphia, was effected. Sommers N. Smith resigned his position as general superintendent of the Newport News shipyard and purchased a large interest in the Philadelphia concern. The new organization of the company is as follows: Mathias Seddenger, president; Sommers N. Smith, vice-president and general manager; Edwin L. Fuller, treasurer, and J. G. Neafie Whitaker, secretary. Directors: Mathias Seddenger, Sommers N. Smith, Eli K. Price, E. L. Levy and John H. Watt. The establishment, which has long had a reputation for good work, will probably go in more extensively for new work in the future than it has for some time past. The works cover about ten acres of ground and it has a water front of about 700 ft. Various plans for the addition of new machinery and a general modernization of the plant are under consideration.

Lieutenant Unsworth and eight under officers and seamen of the French liner La Champagne, who, it will be remembered, put off from the "La Champagne" in a small boat in mid-ocean, when she was disabled, not long ago, for the purpose of getting in the track of steamships and securing aid, received a substantial recognition of their bravery. A reception was held on the vessel when she arrived in port here and a subscription which had been raised by the French residents in New York was divided. Lieutenant Unsworth received 2,000 francs, Second Master Gancamard 1,500 francs and the sailors 1,045 francs each. The Compagnie Generale Transatlantique also presented to each a sum of money and medals. Lieutenant Unsworth also received a very valuable pocket chronometer, which had been purchased by the committee of the passengers who had been on the "La Champagne" at the time of her mishap.

Plans for the construction of the new twin screw ferry steamer for the Toledo & Ann Arbor Railroad Co. call for the construction of a vessel 270 ft. long, 52 ft. beam and 18 ft. 6 in. deep molded, with 'tween decks for cars 16 ft. 9 in. high, fitted with two sets of compound horizontal engines, 20 in. and 40 in. by 36 in. and four firebox boilers 6 ft. 6 in. by 14 ft. worked at a pressure of 125 lbs. of steam. She will be launched with four tracks for twenty-four cars; also made suitable to carry package freight in place of the cars, or grain in bulk in the holds. Otherwise she will resemble the "Pere Marquette," which was extensively illustrated and described in this paper. The designer of the vessel, Robert Logan, of Cleveland, was also the designer of the "Pere Marquette," which has proved herself to be one of the most successful ferry steamers at work in any waters. The contract was awarded the Globe Iron Works.

NEW PUBLICATIONS.

THE MARINE STEAM ENGINE. *A Treatise for Engineering Students, Young Engineers, and Officers of the Royal Navy and Mercantile Marine.* By the late Richard Sennett, R.N., and Henry J. Oram, R.N. Longmans, Green & Co., London and New York. Third Edition, 1898. Size, 6 by 9. Pages 508. With many original drawings. Cloth, $6.00.

There is a decided feeling of satisfaction in store for the purchaser of this book, when he finds, upon opening it, that the author appreciates that such apparatuses as steering engines, starting engines, automatic feed regulators and grease filters form part of the equipment of modern steam vessels. We say this by way of preface to show the comprehensiveness and up-to-dateness of this work. The title of this book indeed is vastly more restricted than its scope. The character of treatment is indicated by the sub-title, as the work is perhaps more intended for the operative than for the constructive department of marine engineering. The work is the outcome of experience gained in the British Navy, the original edition having been long recognized as authority in older naval practice. It was first issued in 1882 by the late Richard Sennett, Engineer-in-Chief of the British Navy. This book gradually took its place, for all practical purposes, among those historical works which treat of trunk engines, box boilers, jet condensers and pressures anywhere from thirty pounds down. The work as now presented has undergone, in the words of the author, "a thorough revision and modernization," and at the same time has been enlarged to countenance the practice followed in the mercantile marine. The illustrations and drawings have been added to, and in this respect alone the work is the most valuable for referencee we know of. There are 412 illustrations in the book, each one well drawn, well executed and of interest. Before giving any details of the work we might say it is intensely practical, very naval, and very British. As the author, however, truly says: "During recent years there has been, as regards the engines of large vessels, a much nearer approximation to identify in mercantile and naval practice than was usual previously." The book is divided into seven sections, entitled: Introductory, The Boiler, The Steam, The Mechanism, The Propeller, General, and Appendix. These again are subdivided into chapters which, among other subjects, include an interesting review of marine engineering practice from the pioneer days to date; Work and Heat, Fuel and Combustion, which includes a very clever chapter on Liquid Fuel, Water-Tank and Water-Tube Boilers, Boiler Fittings and Boiler Preservation, Steam Efficiency and Expansion, Compounding, Valves and Valve Gears, Arrangements of Cylinders, Condensers and Minor Fittings, Propulsion, both screw and paddle, including a practical talk entitled "Co-Efficients and Curves of Performance." The Indicator, Pumps, Auxiliary Machinery, Instructions as to the Care and Management of Machinery, Materials of Construction and Theoretical Indicator Diagrams have also each a chapter. In the Appendix, Stresses and Inertia are considered, and the work closes with the Board of Trade and Lloyd's rules. There is not a waste sentence in the book, nor one which the beginner or veteran cannot read without profit. Much of it is, of course, the alphabet of marine engineering, but this is not irrevocably fixed and the true engineer must ever be the student, also. From the American standpoint there are, of course, many omissions, the beam engine and the stern wheeler, for examples, not receiving attention, and there are also some curious omissions from a purely engineering standpoint. The chapter on Valve Gears is brief and does not take account of some well known patent gears, and in the boiler chapter we noted a failure to treat of the use of retarders. The work is, however, all it claims to be and a good deal more. Its language is so simple and direct that persons not actually engaged in marine work can read it intelligently. It should be found in the library of every steam-yacht owner.

ELEKTROTECHNISCHER UNTERRICHT *und Anleitung zum Betriebe elektrischer Anlagen insbesondere auf Kriegsschiffen.* Lehrbuch für Unterofficiere. Von M. Burstyn, k. und k. Marine-Elektro-Oberingenieur. In Commission bei Carl Gerold's Sohn in Wien. Pola, 1898. Size, 6 1-2 by 10. Pages 352. With 252 drawings.

This book, issued by the Austrian Navy, is an instruction book on electricity and also an instructor in the practical running of electric plants, particularly those of war ships, and is intended for the use of the pretty officers of the navy. The amount of literature on electrical work on ship board is very limited. It is usually either very elementary, disregarding all practical questions, or explaining types of apparatus which are out of date, or contains formulæ which are unintelligible to the average mind, or treats of details which are only of interest to those who are well informed on ship's work. The book in question, however, is a very happy combination of all, as it starts with the elementary problems and leads up to the most modern practice in a way which can be easily understood by beginners. It is profusely illustrated by very carefully made drawings, every one of which clearly elucidates the point in question. Every type of dynamo is explained and valuable hints given in the running of the same. The different styles of multipolar direct driven machines as used in the Austrian Navy are shown, explaining all the details of armature and field coil windings, also the switchboards, and a very interesting account on the electrical outfit used on the latest battleships for training the large guns, working the turrets and ammunition hoists. As the steam turbine is attracting considerable attention nowadays, the description of the Parson's turbo-generator outfit as used on their torpedo boats is of great interest. The wiring of a ship is also very nicely described, also different systems of night signaling with incandescent lamps, and the construction and management of different kinds of searchlights on battleships, torpedo boats, etc. Although the practice in the Austrian Navy differs somewhat from that of the American Navy and merchant marine, and the designs may seem somewhat strange, the principles nevertheless remain the same. The book is very profitable reading matter for any grade of sea-going electricians, and a translation of the same would, without doubt, be highly appreciated.

TRANSACTIONS OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS. Vol. 5, 1897. Edited by the Secretary. Office of the Society, 12 West Thirty-first street, New York. Size, 9 by 11. Pages of text, 247. With many drawings and engravings. Cloth, $10.00.

There is no naval architect, engine designer, or shipbuilder in the country who can afford to leave vacant the place which this volume should occupy on his shelves. Indeed a set of the Transactions is about the most profitable investment in the way of marine literature that we know of. Each volume is a review of the most interesting features of marine practice for the day, which has distinct present professional and commercial value, and in time to come will be of great historical interest. Volume V contains the papers which were read at the fifth general meeting, together with a complete report of every discussion. The discussions, which were participated

in by those in attendance at the meeting, are supplemented by written communications received later, from members who were unable to be present. We need not here reproduce the names of papers and authors, for our readers will doubtless recollect the extensive report of the meeting published in our December issue. A most valuable feature of the Transactions is the number and character of the drawings and sketches which accompany the papers. The make-up of the volume is especially praiseworthy. The pages are well proportioned, the text is set in a large and very readable face of type, the paper is excellent, and the drawings are presented with great distinctness and are of a very workable size. Indeed, in the whole make-up and presentation the Transactions of the Society of Naval Architects and Marine Engineers are superior to anything of the kind that we know of—in the English language.

THE RESISTANCE AND PROPULSION OF SHIPS. By William F. Durand, Principal of the School of Marine Construction, Cornell University. New York, John Wiley & Sons. First edition, 1898. Size, 6 by 9. Pages 431. With 116 figures. Cloth, $5.00.

In marine construction to a greater extent, perhaps, than any other branch of applied science it is unfortunately true that those who know things cannot or will not write of them, and those who do write, often add but little to the recorded knowledge of the subject. It naturally follows that when a work is produced in which the author knows whereof he writes, has something worth writing about, and also knows how to impart the results of his research so that the competent reader cannot but comprehend, he will have an immediate and attentive audience. Such briefly is the character of Prof Durand's work. It is most timely, for there is no branch of shipbuilding practice in which the need of scientific guidance is more felt than in that of design. Competition, not merely of companies or yards, but of nations, has made so important questions of first cost, speed, accommodation, carrying capacity and operating expenses that rule of thumb methods are rapidly becoming unprofitable if not impossible. The work just issued is not offered as a substitute for practical skill and experience, nor as a "table of reference" from which the designer can pick out off-hand any given set of dimensions for any and all conditions. It is rather an aid or guide to the intelligent working out of the proper components of design. It is an unusual blending of the really practical and strictly theoretical, a book that can be read and understood from either standpoint with, of course, the fullest measure of profit when studied from both. There is a woful scarcity of such literature available for ready reference in the drawing room. As the author remarks in his preface, "of the few books in English published in this period (about twenty-five years) those of the highest value have been restricted either in scope or in mode of treatment." He then refers to the publication of isolated papers, on the subject in the transactions of various engineering and scientific societies; but these are, of course, inaccessible to the man in the yard, who has not a national library at his elbow. The book treats of the subject in six chapters entitled: Resistance, Propulsion, Reaction, Between Ship and Propeller, Propeller Design, Powering Ships, and Trial Trips. In the limits of a paragraph it is not possible to give in detail the treatment of each heading. It may be said that each opens with a general statement preparing the way for the more minute treatment which follows, the several components being treated in an orderly and scientifically accurate manner. The chapter on Propeller Design is especially valuable in view of the author's known investigations of this most obscure of all subjects in marine construction. This chapter is made more complete by tables giving data relating to ship and propeller performances on a large number and variety of steam vessels, from warships and passenger steamers to launches. Throughout the work free use is made of graphic exposition of the text. We can recommend this book to the careful attention of those who seriously desire to investigate the laws governing the Resistance and Propulsion of Ships.

MODEL ENGINES AND SMALL BOATS. *New Methods of Engine and Boiler Making, with a chapter on Elementary Ship Design and Construction.* By Nevil Monroe Hopkins. New York, D. Van Nostrand. Size, 6 by 8. Pages 74. With 50 illustrations. Cloth, $1.25.

The purpose of this book appears to be for the exploitation of a special system of construction used by the author, in which the "soldering iron" plays an important part. With a few tubes and sheets of brass as the chief materials, and this convenient instrument, the author shows how to construct small direct acting screw engines and shell and water-tube boilers. The method is ingenious, and would likely prove satisfactory to the amateur who had no knowledge of or taste for the more substantial and workmanlike methods of engineering construction, which embrace the use of castings, machined parts and carefully made screwed and faced joints. Considering the crudeness of the method, however, the designs, as shown, are remarkably good imitations of more thorough workmanship, and the simplicity of construction would probably awaken an active interest among those who would never undertake model work upon conventional lines. Though the work is a useful addition to the scant literature on the subject it would have much better accomplished its purpose had it been carefully edited. There is a noticeable want of comprehension of the subject as a whole, and a lack of orderly systematic arrangement throughout. In places the author plunges into little details without any recognition of principles, and the book is a collection of workshop notes, rather than a comprehensive treatise. A table of dimensions could have been added with much benefit. The illustrations are plainly drawn and should be easily understood.

We have received a copy of the valuable United States Standard Register of Shipping for 1898, published by the United States Standard Steamship Owners, Builders and Underwriters' Association, Limited, 18 Exchange place, New York. This contains, at great length, the rules of the association for the construction and classification of iron, steel and composite vessels, illustrated by an extensive series of drawings. The association is the exponent of the channel system of framing, which has been successfully applied to ships of various dimensions, on both fresh water and ocean service. Rules are also given for the survey and construction of machinery and boilers of steam vessels, and for the use and application of electric lights and appliances on board of ships. There are also extensive tables of scantlings for iron and steel vessels for the coastwise, West Indian and South American trades, and also for transatlantic service. Yachts also receive attention and much data are given concerning the construction of wooden vessels. The Register of Shipping fills nearly eighty pages, and includes the survey records of home and foreign vessels of all descriptions. At the end of the Register there are reproduced a number of letters from leading builders and shipowners expressing confidence in the work of the association.

Fatigue of Metal in Wrought Iron and Steel Forgings, a valuable paper by H. F. J. Porter, of the Bethlehem Iron Co., read before the Franklin Institute of Philadelphia, is issued in pamphlet form and can be had upon application to the company.

TRADE PUBLICATIONS.

"About Traps" is the title to a 3 1-2 in. by 5 1-2 in. neatly printed pamphlet received from the William S. Haines Co., 136 South Fourth street, Philadelphia, Pa. Those interested in traps will find much in this little book to interest them.

An attractive catalogue of over eighty pages, well illustrated, of the various products of the Diamond Rubber Co., Akron, Ohio, is received. These products comprise belting, hose packing and many other rubber goods, such as are used in various branches of marine work.

The Globe Iron Works Co., Minneapolis, Minn., sends us a catalogue of the White gas engines. These engines are made for both stationary and marine work and both types are illustrated and well described. Those interested in gas engines will find a copy of this catalogue worth having.

A catalogue on hose has been issued by the Boston Belting Co., 256 Devonshire street, Boston, Mass. It is 3 1-2 in. by 6 in. in size and comprises twenty odd pages, well illustrated, giving much information regarding the subject of hose and all appliances connected therewith. Copies can be had upon application.

"Friction" is the title of a pamphlet published by the A. W. Cadman Mfg. Co., 63 Water street, Pittsburg, Pa., describing the anti-friction metals manufactured by this company. It contains quite a number of flattering testimonials from some of the most prominent concerns in the country now using these metals, and some detailed information regarding the metal.

The Diesel motor, which has attracted so much attention of late in scientific and engineering discussions, is now being introduced into this country by the Diesel Motor Co., 11 Broadway, New York. Handsomely published catalogues are now ready for distribution, giving a great deal of information regarding this motor as well as a history of its development.

The 1898 catalogue of the Rochester Automatic Lubricator Co., Rochester, N. Y., is received. It comprises forty neatly printed pages and contains a good deal of information regarding these lubricators, which are extensively used in both marine and stationary work. The lubricator is well illustrated and many complimentary letters are published from the users of it.

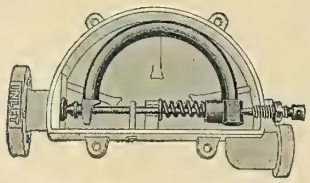
The Lunkenheimer catalogue for 1898 is just received. It is 5 in. by 7 in. in size and comprises 208 closely printed and thoroughly illustrated pages. There is a good deal of information in these pages regarding the brass and iron valves, injectors, whistles, lubricators, oil and grease cups and many other specialties manufactured by this company. Many tables of other important matter for engineers are also given. Any of our readers can secure a copy of this catalogue by mentioning this publication and sending to the Lukenheimer Co., Cincinnati, Ohio.

Two exceedingly handsome catalogues are received from the Sprague Electric Co., 20 Broad street, New York. One is devoted to the "Lundell" fan motors, and has a rich green cover printed in red and gold. The twenty pages are fully illustrated and are splendid specimens of the printers' art. All types of fan motors are shown and considerable detail is given, and sectional views of this well known motor. The second catalogue is devoted to electric motors in the art of printing. It is equally as fine a specimen of press work and is a catalogue which every man should have who is at all interested in the subject of direct connected electric work.

23 Years

in constant use — and no failures. Thousands of dollars saved by the "Heintz" Steam Trap. Simple — Durable — Efficient. Works in any position — discharges water to any height. No floats, no levers or delicate parts. Economizes fuel and labor — saves space — perfectly automatic—requires no watching. Money refunded if trap proves unsatisfactory within a year. Send for one on thirty days' trial free.

Booklet "G" for the asking, will show you how to save money.



William S. Haines Company,

136 South Fourth Street, Philadelphia.

"The Heintz—the best—tho' it has imitators."

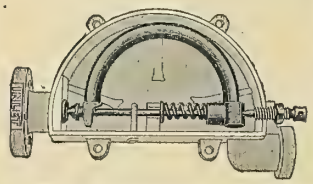
©1 COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 11

Efficiency

makes the value of the "Heintz" Steam Trap — lots of others where you get more iron for your money—lots of imitations, too—and some of them look almost exactly like the "Heintz."

Every puff of steam you lose means a loss of more or less money-profits gone. Use the "Heintz" on your outlets, wherever steam escapes, and you will have an increased boiler capacity. We have saved some concerns large sums—more than we dare say. Can save you something, too.

The cost? Of little moment when traps are needed. Booklet "G" tells the starting point. Get one from us.



William S. Haines Company,

136 S. 4th St., Phila.

"The Heintz—the best—tho' it has imitators."

©1 COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 2

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO.,
JERSEY CITY, N. J.

REDUCING VALVES

to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.

ANTI-FRICTION METAL.

Especially adapted for **HEAVY AND HIGH SPEED ENGINE BEARINGS AND ALL KINDS OF MARINE WORK.**
Outwears, runs cooler and with less lubrication than any babbitt or anti-friction metal made.
Descriptive Circular, Testimonials and Samples Free.
All Kinds of Superior Brass, Bronze, Copper and Non-corrosive White Metal Castings.

FENTON & CO., SELLING AGENTS,
39 Cortlandt St., New York.

Users of coal should have a copy of the finely printed pamphlet issued by the Toms Creek Coal & Coke Co., Norfolk, Va. Figures are given showing the large number of heat units in the coal furnished by this company, and many testimonials are given from some of the largest concerns in the country, that are apparently exclusive users of Toms Creek Coal. A map on the back of the book shows the location of the six collieries of this company.

The Cochrane Separator, manufactured by the Harrison Safety Boiler Works, Germantown Junction, Philadelphia, is very thoroughly illustrated and described in a catalogue just received. The catalogue is 6 in. by 8 in. in size and comprises thirty-six well filled pages, with an abundance of half tone engravings, sectional drawings and complimentary letters regarding this apparatus. Copies can be had by sending to the company and mentioning this paper.

"Light Draught Steam Boats and their Driving Machinery" is the title of a 6 in. by 9 in. pamphlet just received from the Marine Iron Works, Station A, Chicago, Ill. It is very neatly printed on coated paper and the pennant of the company is lightly printed in green ink on each page. The general type of boat manufactured by this company was shown in our January issue, but this pamphlet goes into more detail and gives much information of value to people interested in such boats. Six different types and outfits for Alaskan service are described.

BUSINESS NOTES.

METAL POLISH.—Owing to largely increased demand for Star metal polish, J. B. Cole, manufacturer of it, has moved to larger quarters at 80 Cortlandt street, New York.

BUSY BOAT BUILDER.—Two "Klondike" outfits have just been shipped to the Pacific coast by the Racine Yacht and Boat Works, Racine Junction, Wis., and among other orders are a 15 ft. sailboat and a 20 ft. tugboat for towing logs in northern Wisconsin, the motive power being a gasoline motor; also launches for Florida and for Mexico.

REMOVAL.—Robert A. Keasbey has found it necessary to move and hereafter his office and salesroom will be at 83 Warren street, New York, instead of at 54 Warren street, where he will carry an extensive stock of pipe coverings, paper felt, etc. His Buffalo office still remains at 13 Terrace.

THE LARGEST MOTOR POWER BOAT.—What is said to the largest motor power yacht afloat has just been built at the Daimler Motor Works, Steinway, Long Island City, N. Y. This yacht is the "Coyote" and is 86 ft. long over all, 14 ft. beam, 4 ft. draught, and is equipped with two 25 horse power Daimler motors, each operating its own shaft. This boat has a speed of 12 miles an hour. She has been bought from the Daimler Co. by Eugene Peters, Washington, D. C. Yachtsmen interested in the subject can have full information and a picture of this fine boat by applying to the company.

EFFICIENT REFRIGERATION.—A letter received by the Kilbourn Construction Co., 935 Drexel building, Philadelphia, Pa., from the superintendent of the Vacuum Oil Co., contains the following paragraph which is highly complimentary to the Kilbourn ice machines: "The 9 by 30 ammonia compressor put in by Mr. J. K. Kilbourn in 1890 has run continuously night and day from that time up to the present, and during this period we have only expended about $4 on repairs for this machine. We take great pleasure in giving you this information, as we consider this machine one of the best on the market, both as to efficiency and durability. We claim that this is an extremely hard test on the machine when you take into consideration that we are running our ammonia temperatures somewhere from 10° to 20° below zero."

RAWHIDE PACKING.—The hydraulic rawhide packing manufactured by the Mabbs Hydraulic Packing Co., P. O. Box 829, Chicago, has been on the market for several years and is now used on ocean liners as well as on the lakes and rivers. This packing is composed of strips of rawhide and is very nearly antifrictional. It is well adapted to the many uses in steamship work, especially for propeller stern tubes.

STEAM JOINT CLAMP.—A new device that will interest steam engineers is the Climax Steam Joint Clamp manufactured by James McCrea & Co., 11 South Canal street, Chicago. These clamps will repair leaks on steam joints without pulling out the pipes or shutting down the engine. The clamps are easily put in position and take up very little space. Full information regarding them is printed in circulars.

SAFETY DEVICES.—The engine stops, speed limits and other steam safety devices illustrated in the advertisement elsewhere of the Monarch Manufacturing Co., are being placed upon the market by Mr. Albert Cary, 39 Cortlandt street, New York. Mr. Cary has been well-known for many years as the superintending engineer of the Abendroth & Root Mfg. Co. He has severed his connection with that concern and is now devoting his entire time to these specialties. They are well worth a careful investigation by conservative engineers.

MARINE FORGINGS.—Notwithstanding the fact that the Bethlehem Iron Company, South Bethlehem, Penn., have on their books large orders for guns, gun carriages and forgings for guns, the number of orders which they are taking for merchant work, such as shafting of various descriptions, both solid and hollow, and of plain steel as well as nickel steel, is increasing daily. The products of this well known concern have a world-wide reputation, as the booking of several contracts for armor plate for the Russian Government proved. Last week the company was asked to quote a price on shafting for a Japanese torpedo boat, which is being built in Japan.

ENGINEERING INSTRUCTION.—The American School of Correspondence, 156 Tremont street, Boston, Mass., offers special advantages to the readers of Marine Engineering to secure an education enabling them to pass government examinations. Any of our readers applying for information upon entering a course at once secure a reduction of 33 1-3 per cent. on the regular scholarship prices by mentioning Marine Engineering. The new hand book of this school indicates its scope and character. The instructors are specialists and devote their entire attention to engineering. The officers and instructors of the school are all well known, while the advisory board is composed of such noted experts as Dr. Robert Grimshaw, Charles Thom, Francis H. Boyer and others. Engineers will do well to write for the handbook as per instructions in another column.

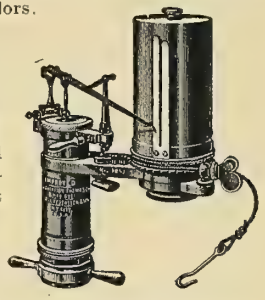
SEND 2 LABELS

cut from front of boxes of EUREKA PACKING and we will send you a pack of beautiful playing cards. All being special in 3 colors.

MARINE ENGINEERS

should own an INDICATOR and know how to use it. Send for circular and *special* prices. It will interest you.

Jas. L. Robertson & Son,
218 Fulton St., N. Y.



LAMPS

For Every Purpose.

We make lamps for Yachts, Boats, Boathouses, Cabins, Wharves, Walks, or anywhere, indoors or out, where a good strong light is wanted.

Our goods need no recommendation from us. They are the standard. Other lamps are said to be "equal to," "like," or "as good as"

THE NEW ROCHESTER.

To be sure the lamps offered you possess the merits peculiar to the genuine, insist on seeing the name stamped in the metal. Catalogue free. We give as much attention to making special lamps, repairs, etc., as to our regular line.

THE ROCHESTER LAMP CO.

42 Park Place and 37 Barclay St., New York.

MARINE ENGINEERS, ATTENTION!

THE AMERICAN SCHOOL OF CORRESPONDENCE

(Chartered by the Commonwealth of Massachusetts.)

Offers a SPECIAL COURSE in MARINE ENGINEERING.

This course has been planned by the foremost marine experts of this country, and is thoroughly practical and scientific.

We are SPECIALISTS, and teach ONLY

Engineering { STEAM / ELECTRICAL / MECHANICAL } { *STATIONARY* / *MARINE* / *LOCOMOTIVE* }

We do not **attempt** to teach anything and everything, but **do** teach the above courses thoroughly and well.
Our corps of trained instructors is selected from the best scientific schools of the country, and they devote their entire time to the students in the above important branches of mechanical science.
Thousands of enthusiastic students endorse and commend the progressive methods of our system of instruction.

SPECIAL OFFER TO READERS OF MARINE ENGINEERING.

33 1-3% DISCOUNT. For the next **30** days we will give readers of MARINE ENGINEERING a reduction of 33 1-3 per cent from our regular scholarship price (easy terms if desired).
Your name on a postal card will bring you a handbook of the school, containing complete schedules of courses, pages from instruction papers, etc., etc. FOR 30 DAYS.

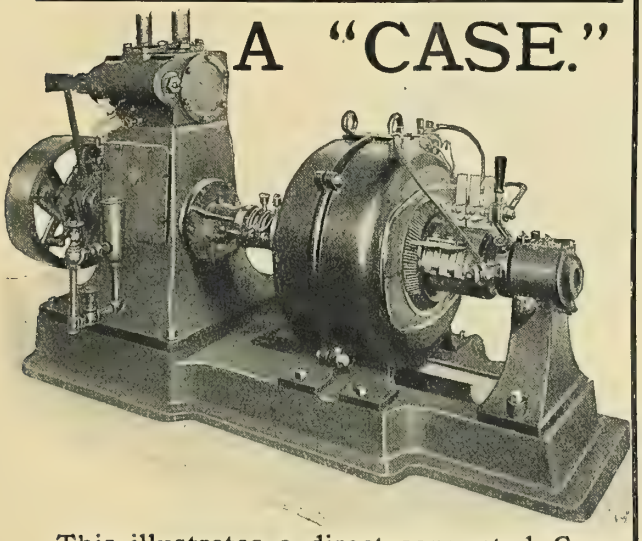
YOU CANNOT AFFORD TO MISS THIS OPPORTUNITY.

AMERICAN SCHOOL OF CORRESPONDENCE, 156 Tremont St., BOSTON, MASS.

EMPIRE MOTOR.—The Empire Motor which is illustrated in our advertising columns was put upon the market last year. It has already made a reputation for itself because of its compactness, simplicity and design. The principal feature is the control of the air supply, permitting the motor to be run at a very slow speed. These motors are of the four-cycle type. The company furnishes reversing gear or reversable propellers. The exhaust of these motors is under water and there are no moving parts on the outside except the fly-wheel. Lubrication is automatic, and the use of electric batteries has been done away with and the ignition current is generated mechanically by the revolving of the fly-wheel. All motors are double cylinder with the exception of the one horse power and they are made up to twenty horse power in size.

MARINE ELECTRIC LIGHTING PLANTS.—One of the standard engines for use in marine electric plants for years has been the "Case," manufactured by the New Britain Machine Co., New Britain, Conn. Two types of direct connected plants in which this engine is used are shown in our advertising columns this month. The one with the "Lundell" dynamo, manufactured by the Sprague Electric Co., New York, is the type that has been used by the Merchants & Miners Transportation Co. for the "Juniata," which was fully described in our December issue. This steamer is now the floating machine shop for the United States Navy. This plant has a capacity of 250 lamps of 16 candle power and takes up no more room than an ordinary rolled top desk. The other plant shown is a "Case" engine direct connected to an "Eddy" dynamo, manufactured by the Eddy Mfg. Co., Windsor, Conn. Several rigs of this kind have been furnished for use on Yukon river steamers. The many characteristic features of the Case engine are fully told and described in publications issued by the company. Every engineer interested in marine electric plants should send to the company for further details.

A "CASE."



This illustrates a direct-connected Case engine and Lundell dynamo, two sets of which are on the M. & M. Steamship Juniata, purchased by the government as a floating machine shop.

Send for particulars.

NEW BRITAIN MACHINE CO.,
NEW BRITAIN, CONN.

Look at the picture in our advertisement on page 57.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

POSITION WANTED.

A superintendent of works doing a general line of marine and stationary work, engineering, boiler and tank making, and general contracting, including jobbing and repairs, and who makes estimates, contracts, drawings, and follows up the work both in the shops and outside, wishes to change. Address "SUPERINTENDENT," care of MARINE ENGINEERING.

POSITION WANTED.

Mechanical Engineer, 15 years' experience in shop and designing; has handled men in own business; desires responsible position not confined to office; marine and general machinery. Address X, MARINE ENGINEERING.

PROFESSIONAL CARD.

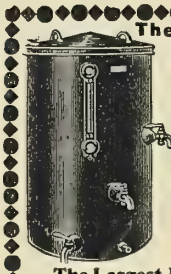
H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.

Manufacturer of **Screw Propellers** for Usual and for Special Work.

The Allen Dense Air Ice Machine for Steam Vessels.

41 MAIDEN LANE, NEW YORK.



The **CROSS OIL FILTER**

actually reduces oil bills 50% or more. Sent on approval. Used in 17 countries. Adapted to steam vessels of every description. Send for circulars, testimonials, etc.

THE BURT MANUFACTURING CO.
AKRON, OHIO, U. S. A.
The Largest Manufacturers of Oil Filters in the World.

GOLDEN'S PROPELLERS.—Captain Samuel Golden, 178 Ohio street, Buffalo, N. Y., is designer and maker of what he calls the "perfect propeller wheels." The captain has sailed on the lakes for many years, lately as master of the high speed yacht "Enquirer." A circular regarding these propellers can be had by applying for it.

MARINE ELECTRIC WORK.—Edward R. Knowles, for many years the engineer for electric instalment and consulting engineer for the Brooklyn Bridge and other large plants, has become manager of the power motor department of the Sprague Electric Co., 20 Broad street, New York. Being a specialist in this line, he is prepared to make any repairs for the installation of electric plants for steam vessels, shipyards or other marine uses.

MARINE ELECTRIC LIGHT PLANTS.—Morton, Reed & Co., Baltimore, Md., have been very busy this spring. They have just fitted up a new 125 ft. yacht for William H. Evans, of that city, with all necessary machinery, and have just sold three double cylinder direct-connected automatic engines with dynamos attached for lighting steam vessels. Full information regarding these engines can be had upon application. This firm has recently been appointed agent for the Sprague Electric Co., New York.

NEW JACKET TUBING.—The Excelsior Jacket Tubing is one of the recent products which the Boston Belting Co., 256 Devonshire street, Boston, Mass., is putting on the market. This tubing is neatly boxed and each box contains all necessary couplings and electric tape for winding the joints. It is of superior quality, and the coupling device is believed to be a considerable improvement over many old methods. A four-page folder regarding this tubing is sent to all inquirers.

RAINBOW PACKING

Makes a Steam Joint Instantly.

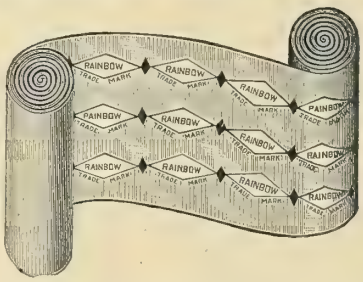
HONEST JOHN.

MR. JOHN H. DEMING.
General Superintendent Peerless Rubber Manufacturing Co.

THE COLOR OF RAINBOW IS RED.

NOT AFFECTED BY OILS, AMMONIA LIQUORS, STEAM HEAT OR ALKALIES.

None genuine without the Trade-Mark.



RAINBOW PACKING HAS 3 ROWS OF DIAMONDS IN BLACK EXTENDING THROUGHOUT THE ENTIRE LENGTH OF EACH AND EVERY ROLL.

Fac-simile of a Roll of Rainbow Packing.

Who invented and who is the only man in the world who can make or ever has made

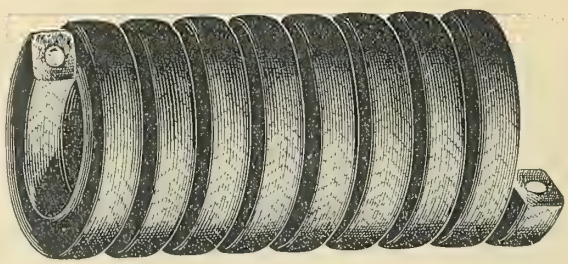
Rainbow Packing.

RAINBOW GASKETS are especially adapted for Low Pressure Steam and Hot Water Heating Apparatus.

PEERLESS DISCS for Russell, Frink, Walworth, Jenkins, Lorain and Kelly & Jones Valves.

"HONEST JOHN."

Made in both Straight and Spiral Form.



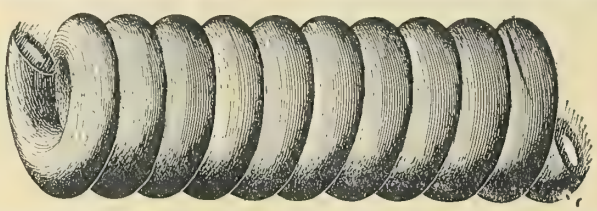
Once Tried, Always Used.

Put up in Boxes.

HYDRAULIC RAINBOW CORE PACKING.
The Best Hydraulic and Cold Water Packing in the World.

Hercules Combination.

Always Tight. Leaves the Stem Clean.



Will Hold 400 lbs. Steam.

Metallic Stop Valve Packing.

SEND FOR CATALOGUE.

Patented, Copyrighted and Manufactured Exclusively by

THE PEERLESS RUBBER MANUFACTURING CO.,

16 Warren Street, New York.

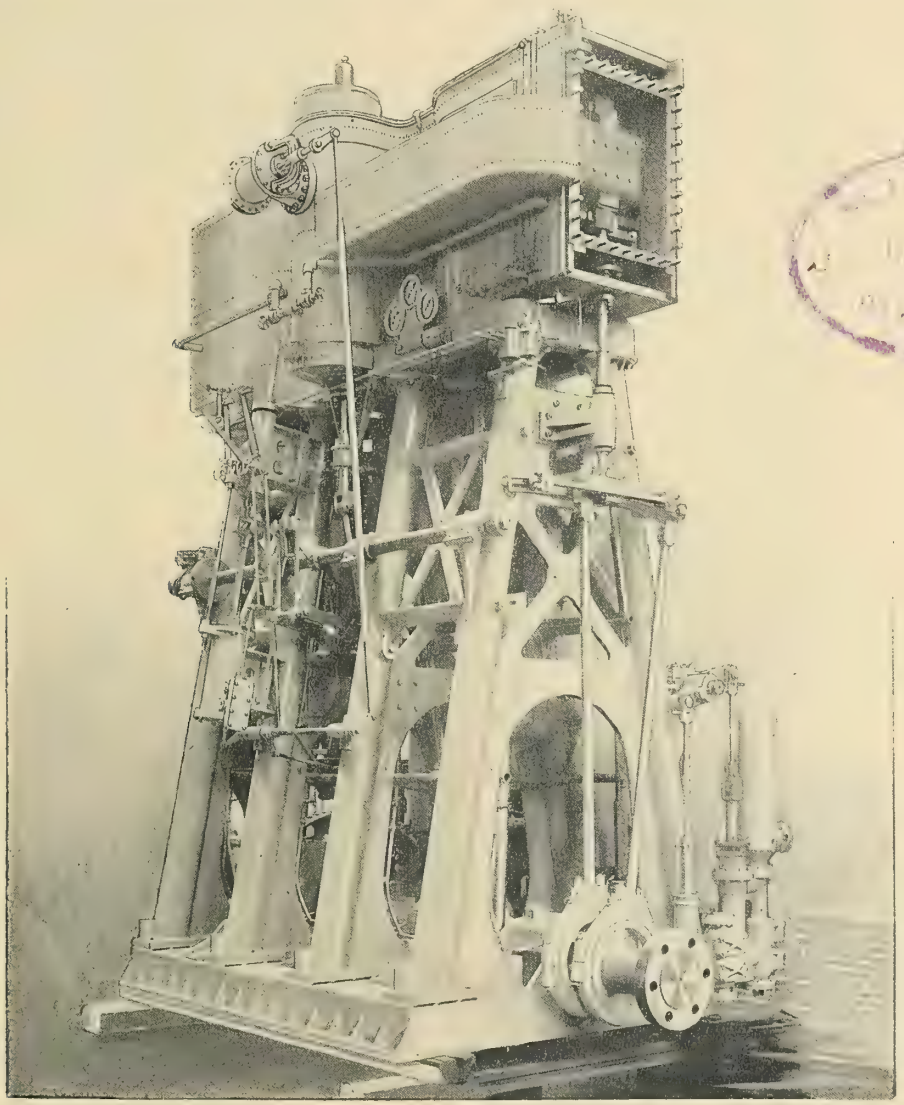
16-24 Woodward Ave., Detroit, Mich. 202-210 So. Water St., Chicago, Ill
17-19 Beale St., and 18-24 Main St., San Francisco, California.

MARINE ENGINEERING.

Vol. 2. NEW YORK, JUNE, 1898. No. 6.

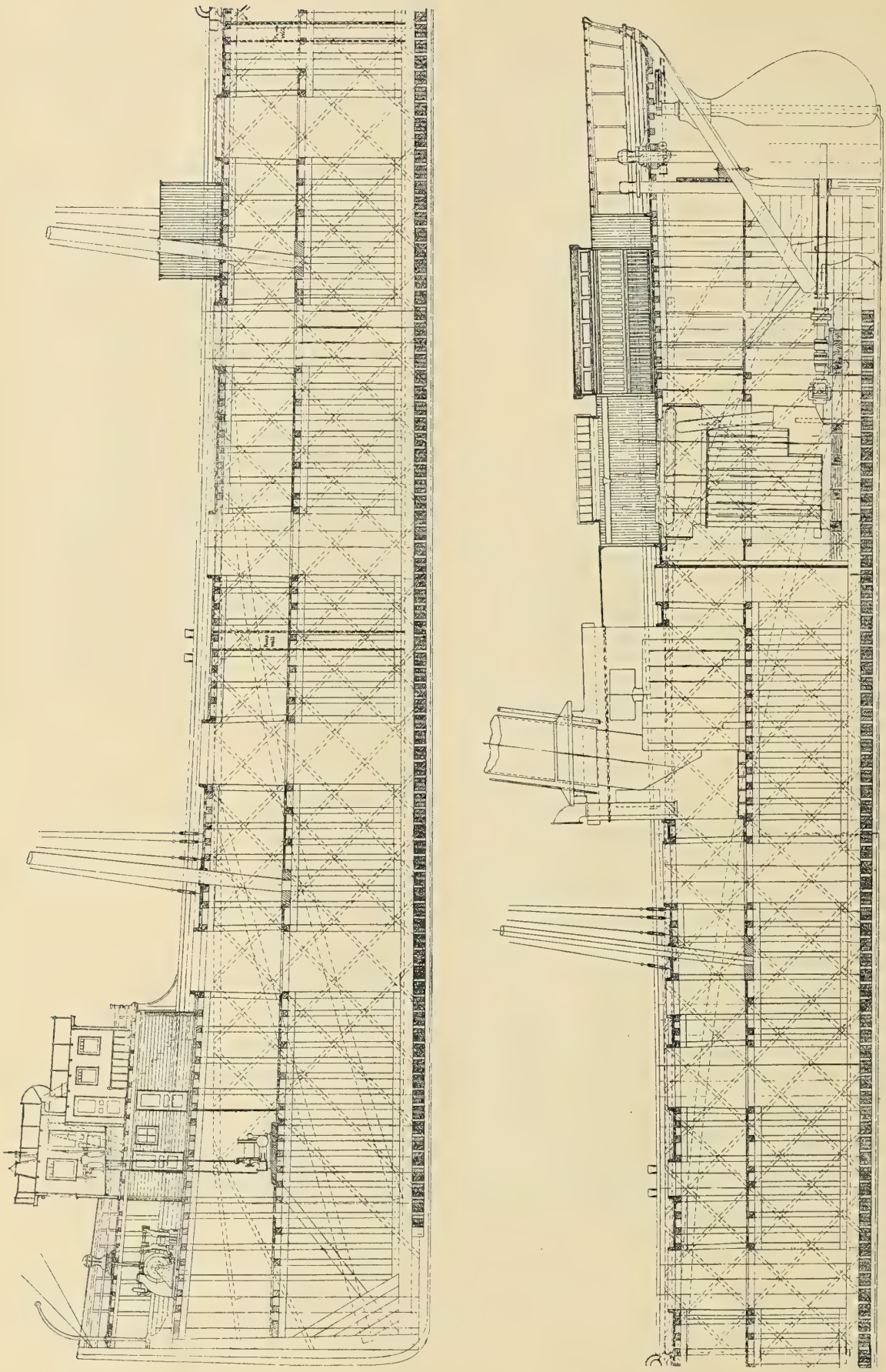
DETAILS OF LARGEST WOODEN STEAMSHIP IN COMMISSION IN THE WORLD.

Although in deep-sea trade steel has superseded wood for steam vessels, there is still a considerable demand for large wooden steamers on the Great Lakes. Perhaps the most interesting of all the wooden cargo vessels engaged in lake traffic is the steamer Thomas Cranage. She is the largest wooden steamship ever constructed on the Great Lakes, and, so far as we know, the largest wooden steamer in commission in the world. In the water she is a neat-looking boat, as will be noticed by reference to the engraving on page 3. She was built in the yard of James Davidson, Bay City, Mich., where many of the



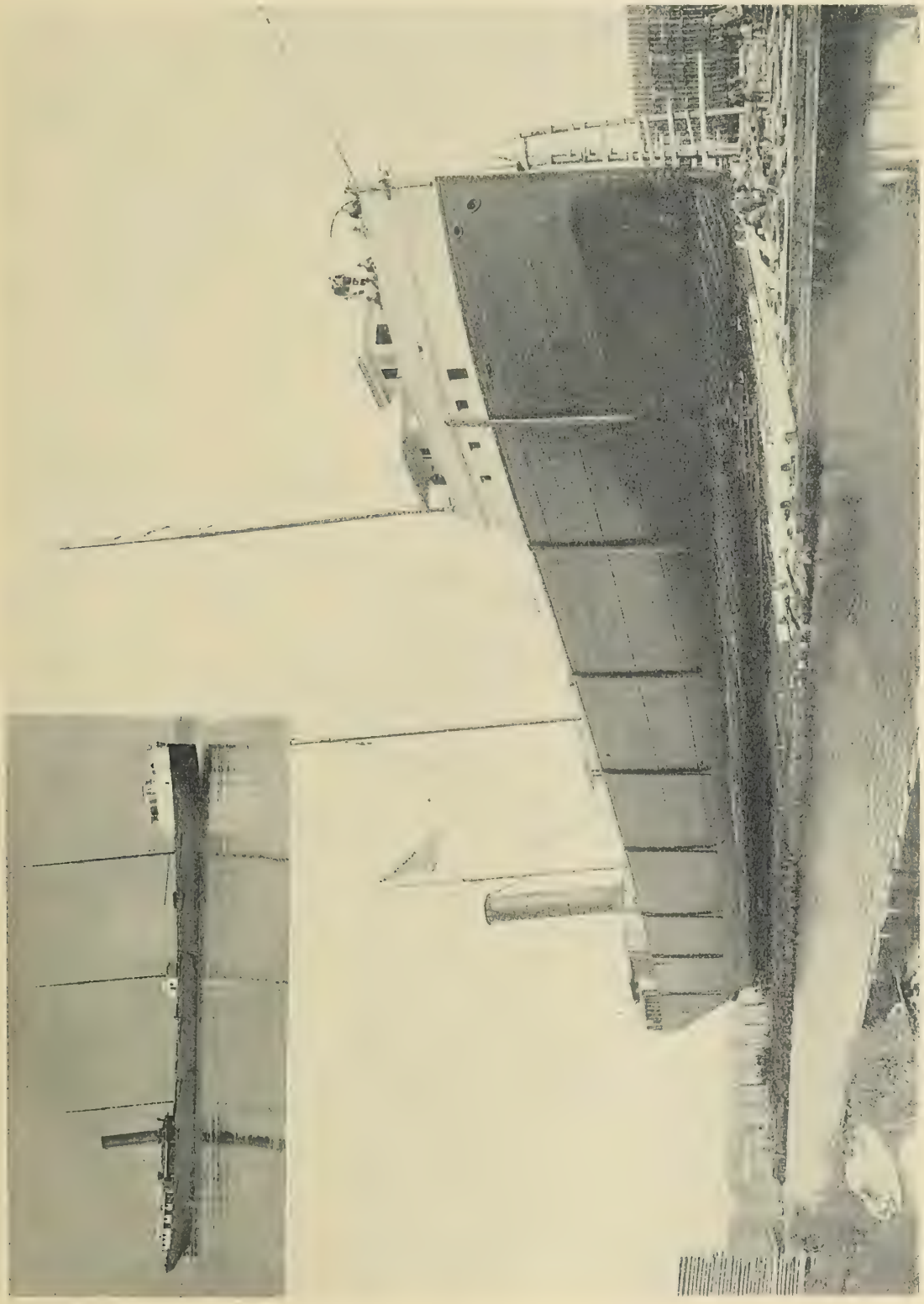
TRIPLE-EXPANSION ENGINE OF LAKE STEAMER THOMAS CRANAGE.

Copyright, 1898, by Marine Publishing Co., New York.



LONGITUDINAL SECTION OF THE WOODEN LAKE STEAMSHIP THOMAS CRANAGE, BUILT BY THOMAS DAVIDSON, BAY CITY, MICH.

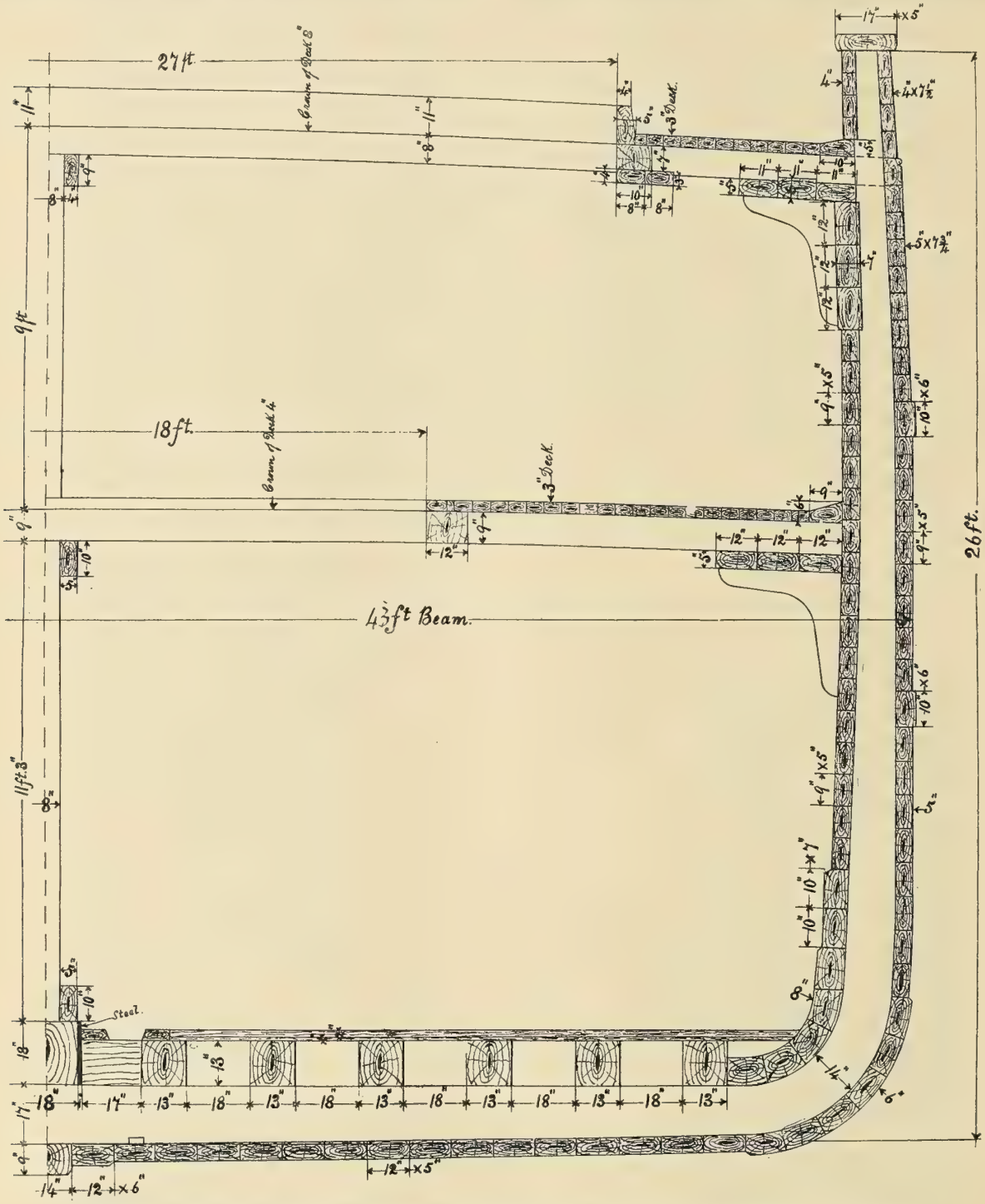
largest wooden vessels on the lakes have been launched. The method of construction can be seen in the sectional drawings, pages 2 and 4.



STEAMSHIP THOMAS CRANAGE AS SHE APPEARED READY FOR LAUNCHING AND AT SEA.

Her extreme length is 330 ft., extreme beam 43 ft., in moulded depth 26 ft., and depth of hold in shoalest place 20 1-2 ft. The frames are moulded from 6 in. flitch, doubled, and on each frame there is an extra floor 6 in. thick, in one piece, running from bilge to bilge. This makes almost an entirely solid bottom. The frames are all spaced 22 in. from center to center, and are moulded 17 in. deep at the throat, 14 in. at the

bilge, and 7 in. at the top. The keel is 14 in. by 9 in. The garboard strakes are 12 by 6. The main kelson is 18 in. by 18 in., and on each side of the main kelson there are fastened steel kelson plates that are riveted together with fish plates, These floor kelsons are 13 in. by 13 in., and run the entire length. On top of the floor kelsons the floor is laid, and this consists of one thickness of 1 in. oak and one thickness of 2 in. oak. The bilge kelsons are 8 in. thick for five strakes



HALF CROSS SECTION OF S.S. THOMAS CRANAGE SHOWING DIMENSIONS OF TIMBERS.

and the steel kelsons are securely bolted to the main kelson. The steel kelson is 18 in. wide and 1 in. thick. There are twelve strakes of floor kelsons, six on each side of the main kelson. and 7 in. thick for two strakes. The ceiling is all 5 in. thick. The lower shelf piece is in three strakes, each strake being 5 in. thick by 12 in. wide. The lower hold stanchions are 8 in. by

8 in. The stringers at the bottom of the stanchions and the stringers at the top of the stanchions are 5 in. by 10 in. The stanchions supporting the upper deck run from the lower hold through the main deck to the upper deck. The clamp strakes are in three strakes, 12 in. by 7 in., and each strake of clamps is notched on to the frame 2 in. The stringers from the rail to the upper deck are 4 in. thick, and these stringers are notched on to the frame 1 1-2 in. The upper shelf piece is in three strakes—two strakes 5 in. by 11 in. and one strake 6 in. by 11 in. The center strake of the upper shelf is notched on to the deck beams 1 in. The upper deck beams are 8 in. by 8 in. and 8 in. by 10 in., and there is a deck beam on every frame. The lower deck beams are 9 in. by 9 in. and 9 in. by 10 in., and they are spaced on every other frame. Under the upper shelf beneath each deck beam, as well as under the lower shelf on each side, is a tamarack ship knee, and these knees are thoroughly bolted to the shelf and deck beams, as well as to the side of the ship. The rail is 17 in. wide by 5 in. thick. The planking on the bottom is 5 in. thick to the turn of the bilge, and around the turn of the bilge the planking is 6 in. thick. From the turn of the bilge to the plank sheer the planking is 5 in. thick. There are also two wale strakes 10 in. wide by 6 in. thick.

The entire construction of the Thomas Cranage is of the best Michigan white oak, with the exception of the deck planking, which is the best Michigan white pine. The deck plank is all 3 in. thick by 5 in. wide. The main kelson is fastened through kelson, frame and keel with five bolts in each frame, each 1 1-8 in. dia. The floor kelsons are all fastened with three bolts in each frame, each 1 in. dia. The bilge kelsons are all fastened with all-through fastening, all bolts being 1 in. dia. The ceiling and planking is all fastened with through fastening, all bolts being 7-8 in. dia. These bolts are driven from the outside through planking, frame and ceiling, and they are fore locked with clinch rings on the inside. The bottom plank is all fastened with 12 in. by 1-2 in. boat spike. The bilge kelsons are all edge bolted with 1 in. irons. The ceiling is all thoroughly edge bolted with 7-8 in. round iron. These bolts in length are driven through two full strakes and into half of the third strake. The outside planking is also thoroughly edge bolted with 7-8 in. round iron, and these edge bolts are driven through two full strakes and into half of the third strake. In addition to the edge bolting of the ceiling and the planking, and in addition to the through bolting of the ceiling and the planking, two spikes are driven in every frame, and of every strake of the ceiling, as well as of the planking.

At the head of the frames for the entire length there is run a steel cord 14 in. by 7-8 in. in dimensions. This cord is let into the frames flush. There is also run a steel arch 14 in. by 3-4 in. from the extreme forward end to under the stern aft. In addition to these, there is a branch running from the cord forward under the fore foot forward, and from the cord aft under the shoe aft. Diagonal straps 5 in. by 1-2 in. are riveted to the cord, also to the arch, and these diagonal straps are 5 in. by 1-2 in., and they run down under the turn of the bilge, and one-third of the way under the bottom. These diagonal straps are also riveted at all of the crossings. On the inside ceiling there is also run a steel arch 14 in. by 3-4 in. from the forward end to the after end. This arch is also securely bolted to the ceiling, and to the frames.

There are nine cargo hatches, each 28 ft. long by 7 ft. wide all spaced 24 ft. centers. Eight of these hatches being forward of the boilers and one being abaft of the boilers. There are also two fueling hatches and bunker capacity for 300 tons of fuel.

The quarters for the officers are all arranged forward. The captain's quarters are in the texas, and these consist of a bedroom, sitting room and office. These quarters are all in the white oak, cabinet finish. The quarters for the firemen and deck hands are in the deck house amidships. The oil and lamp rooms are also in the house amidships. The galley, mess rooms and dining room are located aft, and these rooms are also in white oak, cabinet finish, with decorations in lincrusta walton.

The steam steering gear is a combination hand and steam steerer, by the Globe Iron Works, of Cleveland, Ohio. The steering engine is located on the main deck forward. The steam windlass and steam capstan are also located forward. Both wild cats are fitted for 1 3-4 in. stud linked chain, and the chain lockers are right under the windlass on the main deck forward. The anchors, two in number, each weigh 3,000 lbs. They are Troutman's latest improved. On the quarter deck is the steam capstan, the engine for operating it being located on the bed plate, right under the upper deck. Amidships there is also a steam deck hoister for the purpose of lightering cargo. To the drums of this deck hoister are also attached plungers for the bilge pumps, so that they can be used in case of an emergency.

The steamship Thomas Cranage has two heavy breast hooks and heavy pointers forward. She also has two heavy breast hooks and two heavy pointers aft. The rudder has the stock incased in a 16 in. steel sleeve. The rudder is supported by a rudder supporter, as well as by a heavy iron shoe. The tiller ropes operate on the rudder by means of a quadrant. This ship is supplied with three pole spars, which are stepped in the main deck. There are also two large pump wells running from the upper deck to the floor, which are 5 ft. sq.

The government gross tonnage of the Thomas Cranage is 2,219.52 tons. The net tonnage is

1,855.59 tons. Her capacity is 110,000 bushels of wheat, on an even draft of 16 1-2 feet. She has also carried 3,050 gross tons of iron ore, on a draught of 16 ft., 8 in. Her weight in the water is 4,000 tons.

The motive power consists of a fore and aft triple expansion engine, built by the Dry Dock Engine Works, of Detroit, Mich. The cylinders are 20 in., 33 in., and 54 in., with a stroke of 42 in. The engine is equipped with air pump, condenser, feed, bilge, and circulating pumps, and the cranks are set 120 deg. apart. A universal coupling is fitted between the crank and thrust shafts. The engine is equipped with link motion valve gear and steam reversing gear, with water cylinders. The cylinders and throttle valves are fitted with relief valves. The feed pipes and all the main pipes about engine and boiler are of copper.

The boilers are two in number, also built by the Dry Dock Engine Works. These boilers are each 14 ft. dia. by 12 ft. long, each having three furnaces, and return tubes of 3 1-2 in. dia. The boilers are built of Siemens-Martin steel, of 60,000 lbs. tensile strength, and built to withstand a working pressure of 160 lbs. per sq. in. Under the boilers are placed nine 9 in. I beams, weighing 25 lb. per ft. On top of these beams is placed the ash-pan, running from side to side. To these the boilers are thoroughly fastened. The drain from the ash pan runs to the bilge. The boiler house is built entirely of steel. The tees forming the stanchions are 3 1-2 in. by 3 1-2 in. The plates or panels are 25 in. wide, of No. 10 steel. The roof is made of No. 10 steel, and the panels are fastened by smoke stack rivets to the tees. The syphons are arranged forward and aft, and there is also a Worthington's duplex steam pump, 6 in. by 4 in. by 6 in., with 3 in. suction, for the purpose of filling the tanks, and also washing ship. The feed pump is of the Worthington pattern, 7 in. by 4 in. by 10 in. The boiler is also supplied with Penberthy injector. Speaking tubes connect the engine room with the boiler room, and also the pilot house with the engine room.

The steamship Thomas Cranage is a very fine model, is a handsome ship, and makes at an ordinary gait in ordinary weather thirteen and one-half miles per hour. This is an economical rate of speed, although she has been "crowded" to make fourteen miles per hour. She is classed A1* in the Inland Lloyds Insurance register, and is owned by Thomas Cranage, Major S. P. Cranage, J. W. McGraw, Captain John S. McNeill, H. H Norrington, all of Bay City, Mich.; G. A. Tomlinson, of Duluth, Minn., and Edward Smith, of Buffalo.

An interesting article on the "Development of the Torpedo-Boat Destroyer," by John Platt, who has had much experience in this direction, appears in the May issue of the Engineering Magazine.

MARINE GASOLINE AND GAS ENGINES AS USED IN MODERN MOTOR BOATS.—I.

BY CECIL H. PEABODY, M.E.

The recent developments of various forms of gasoline and oil engines, especially for running launches and small boats, shows that they are meeting the demand for a convenient and safe way of developing power on a small scale. It is believed that a simple statement of the principle of such engines and the difficulties met in their design and construction will be of interest.

All such engines belong to the class of internal combustion engines, since the fuel is burned inside the cylinder of the engine, and the heat generated is applied directly to heating the air that forms the real working substance in the engine. Consequently all gas and oil engines are really hot air engines. The burning of the fuel in the air is merely a very ingenious and effective way of heating the air. After the air has done its work in the cylinder it is thrown out in the exhaust, carrying the heat with it which the engine cannot use and must reject in some way. As compared with a steam engine, the gas engine has two advantages; it does away with the cumbersome boiler, and it allows the use of a wide range of temperature. Here and elsewhere it will be convenient to use the name gas engine for all internal combustion engines, and since in almost all cases the fuel is first gasefied or vaporized before it is introduced into the cylinder the name is proper. If the gas is made from a solid fuel like coal, then the apparatus for making and purifying the gas must be included as part of the plant, whether that be a gas works which makes gas for general consumption or a special apparatus like the Dowson gas generator. The first gas engines used illuminating gas and were employed mainly on account of their convenience, which offset the high price of the fuel used. Large recent gas engines with their own gas generators are now coming into use on account of their economy. Clearly enough, such a cumbersome method of making and using gas is impossible on a boat or for any form of portable engine. The most ready way of making gas is to vaporize some volatile liquid like naphtha or gasoline; consequently the earliest forms of gas engines used for small boats or for motor carriages were merely gas engines which used the vapor of some of the light petroleum products. In England, where legal restrictions interfere with the general handling and use of naphtha and gasoline, much has been done in the line of oil engines, which are constructed to use kerosene oil; but high grade illuminating oil cannot be readily vaporized, and in consequence such engines have difficulties of their own in addition to those common to all gas engines. Two engines have been made thus far which can use heavy oils like petroleum or petroleum refuse, namely the Brayton engine and the Diesel motor; one of these has apparently been abandoned, though it

had some promising features, and the other appears to be at the beginning of a successful career. By far the most experience has been had with gas engines, and the conditions controlling the economical use of internal combustion engines have been discovered in connection with that experience. But since all such engines, with the exception of those using heavy oils, first vaporize or gasefy the fuel before using it and are really gas engines, the conclusion from our experience with the older form can be applied with little or no modification to gasoline and oil engines. This method of dealing with the general problem clears the field and makes it easier to understand the special problems of the later forms of engines.

In order to clearly understand the problems of rapid combustion or explosion, as in the cylinder of a gas engine, it is well to give some attention to the general theory of combustion. Any form of chemical combination which is rapid enough to generate much heat may be considered to be a combustion, but the name is applied usually to rapid oxidation of fuels like wood, coal and gas. The temperature developed by combustion of fuel depends largely on the composition of the fuel, but it depends even more on the rapidity of the combustion and the precaution taken to avoid or to provide for dissipation of heat. The more finely divided the fuel and the more intimately it is mixed with air, the more rapid the combustion will be. Thus forced draft, which draws many fine streams of air through fuel on the grate of a locomotive, gives rise to a high temperature; but on the other hand the walls of the fire box and the tubes rapidly carry away the heat from the fire.

Now the gas and air supplied to a gas engine are thoroughly mixed and are enclosed in a cylinder. When ignited the combustion is so rapid as to cause an explosion, the rise of pressure being due to the heating of the air during the combustion. The explosion, however, is not instantaneous, though the time required is only a small fraction of a second. In much the same way a fluid like kerosene oil may be sprayed in such a way as to be intimately mixed with air and exploded. In oil engines, however, the spraying is so arranged to give at least a partial vaporization. But a solid like coal dust may also be made to give a real explosion. Explosions of air charged with fine flour dust gave rise to a most notable series of disasters only a few years ago.

All internal combustion engines are cooled by water jackets, that is by making the cylinder with double walls through which water can be circulated. These water jackets carry away much heat which is totally wasted, and the only reason for using them is that it is impossible to run an engine with a metallic cylinder unless it is so cooled. As yet no material which can endure a high temperature has been found, which is at all suitable for making engine cylinders. And yet these water jackets have comparatively little effect on the temperatures attained in gas engine cylinders or on the pressures produced in consequence of the explosion.

The temperature realized in the cylinder of a gas engine is limited by the phenomenon of dissociation. For if carbonic acid, which results from the oxidation of carbon in coal, is heated sufficiently it will break up again into carbon and oxygen; in much the same way water or steam may be broken up into its elements, hydrogen and oxygen. Long before the temperature of dissociation is reached in the cylinder of a gas engine, the action which is known by that name begins to affect the combustion, for as the temperature rises the combustion becomes less active and finally ceases, leaving much of the gas unburned. If the pressure of the gas in the cylinder is reduced by expansion, as is the case with all gas engines, the temperature falls at the same time, and the combustion, previously checked by dissociation proceeds, and commonly lasts to the end of the stroke of the piston. The temperature attained by gas exploded in the cylinder of a gas engine is from 2,000° to 3,000° F., depending mainly on the compression experienced by the gas before the explosion. It is a curious feature of the gas engine that the heat yielded by this "after burning" (to translate a German expression) compensates the heat lost to the cold walls of the cylinder, so that the actual expansion curve is something like what would be obtained were there no loss of heat to the walls and no generation of heat after the initial explosion.

Now the efficiency of any heat engine depends on the temperature of the working substance. Just how the efficiency shall be calculated from the temperatures depends on the kind of engine. But even if the problem becomes too complicated to be expressed by a mathematical equation, as is the case for the actual steam engine (taking into account initial condensation and re-evaporation), we know that an increase of the working range of temperature, under proper conditions, gives an increase in efficiency. For example the steam consumption of a steam engine may be reduced by raising the boiler pressure or by using a vacuum. But the temperature of steam rises with the pressure in the boiler, and the exhaust steam is cooler with than without a vacuum.

Coming to the case of the gas engine it appears that the upper temperature, that is the temperature after explosion, is limited by dissociation. If there were no such a thing as dissociation it would be well to use just air enough with the gas to give complete combustion, since in that case we should have the least possible weight of products of combustion, and consequently the heat developed by combustion (which in a gas engine is applied mainly to heating the gases resulting from the combustion), would give the highest possible temperature, and the greatest

efficiency. Unfortunately such an attempt does not give any higher temperature—it only gives more unburned fuel, and consequently more waste. The proper method is to use as much air as possible, so that the heat of combustion being spread through a greater weight of combustion may be better developed before the phenomenon of dissociation intervenes to stop combustion.

This explains why weak mixtures of gas and air are preferred in gas engines. In practice the mixtures are made just as weak as may be, without running danger of missing an explosion, for if the air in excess is beyond a certain fairly definite amount the mixture will not explode. The consequence of all this is that the way of governing a gas engine is to omit an explosion, and this leads to various troubles when gas engines are used for propulsion.

In this connection we may properly consider the gain which has been found from increasing the compression in gas engines before explosion. This gain comes in part from the heating of the gases during compression, so that the heat supplied by the explosion is on the whole supplied at a higher temperature, but the main advantage is due to the greater expansion after explosion which accompanies a greater compression before explosion. This greater expansion gives a better chance for development of heat of combustion by after burning, and also gives a cooler exhaust.

The advantage of using high compression is clearly shown by the following table of tests on Otto engines:

Diameter of cylinder, inches..	9	9.5	7
Stroke, inches.....	18	18	15
Ratio of compression span to piston displacement.....	0.6	0.4	0.34
Pressure of compression above atmosphere.....	38	61.6	87.5
Cubic feet of gas per horse power per hour.....	24	20.5	14.8
Actual efficiency.....	0.17	0.21	0.25
Theoretical efficiency.....	0.33	0.40	0.428
Ratio of efficiencies.....	0.51	0.53	0.58

By the efficiency of a heat engine we mean the ratio of the heat changed into work to the heat supplied to the engine. For the gas engine, the heat supplied is taken to be the heat of combustion of the gas. The heat change into work is determined by dividing the indicated work of the engine by 778, that is by the mechanical equivalent of heat.

The method of making the calculation of efficiency for a given engine test will be instructive and interesting. Dr. Thurston reports that an engine which indicated 9.6 horse power used 24.5 cubic feet of gas per horse power per hour. This gas had a volume of 26.43 cubic feet per pound, and one pound when burned in a calorimeter developed 16,320 thermal units. It therefore appears that one cubic foot would develop

$$16,320 \div 26.43 = 617.6$$

thermal units. Consequently the gas used per horse power per hour would develop

$$617.6 \times 24.5 = 15,120$$

thermal units. This may be taken as the heat supplied to the engine per horse power per hour. But a horse power is 33,000 foot pounds per minute or,

$$33,000 \times 60 = 1,980,000$$

foot pounds per hour. Since 778 foot pounds are equivalent to one thermal unit, one horse power is equivalent to,

$$1,980,000 \div 778 = 2,545$$

thermal units per hour. Therefore the actual efficiency for this test was,

$$2,545 \div 15,120 = 0.168$$

which is as good as that of a first class steam engine, not taking account of the losses of heat at the furnace and boiler. This by itself shows why gas engines of small power can compete with steam engines, even when they are handicapped by the high price of gas.

It is interesting to know that Dr. Thurston found further the distribution of heat to be

Work indicated in the cylinder.....	17
Heat carried away by water jacket.....	52
Heat carried away by exhaust gas.....	15.5
Heat lost by conduction and radiation..	15.5
	100.0

This brings out the enormous loss due to the cooling of the cylinder. It looks at first sight as though half the heat might be saved by using some non-conducting material for the cylinder. But since it is not likely that the temperature in the cylinder would be much affected by such a change (for we have seen that it is limited by dissociation) it is at least questionable whether the suppression of the water jacket would lead to a very great gain in economy.

Fig. 1 represents the indicator diagram from an oil engine, which, however, is of the same form as the diagram from a gas engine, or a gasoline engine. The cycle of operations requires four strokes of the piston. From *a* to *b* a charge of gas and air is drawn into the cylinder, the pressure meanwhile falling a little below the atmospheric pressure; from *b* to *c* the charge is compressed, the pressure in this case amounting at the end of the stroke to eighty pounds. At the end of compression the charge is ignited, and an explosion occurs, which is rapid but not instantaneous. After the explosion the pressure in the cylinder was about 240 pounds. The expansion *d e* reduced the pressure to about 40 pounds, and from *e* to *f* the pressure fell nearly to that of the atmosphere.

The deduction of the theoretical efficiency involves the use of some elementary thermodynamic equations, but it is well worth while, as it gives a means of comparing the possibilities of different types of engines, and also gives a standard with which the actual performance can be compared. Thus in the preceding table com-

paring three Otto engines, it appears that the engine with the highest compression gave not only the best absolute efficiency, but also the best relative efficiency when compared with the theoretical efficiency.

For sake of simplicity the diagram of the engine will be assumed to be represented by Fig. 2, which differs in appearance from Fig. 1, be-

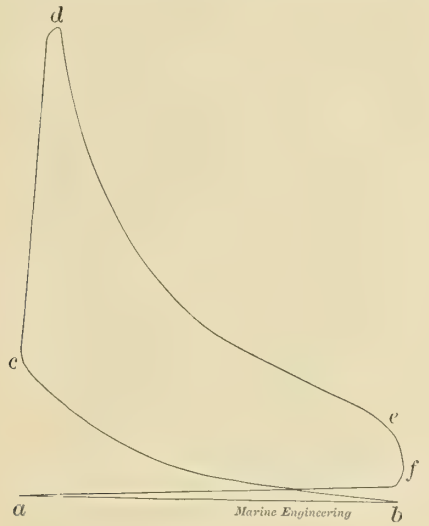


FIG. 1.

cause the explosion *c d* is supposed to be instantaneous and because the release is assumed to be at the end of the stroke. Let it be assumed, further, that the combustion is finished at *d* and that during the expansion from *d* to *e*, and also during the compression from *b* to *c*, no heat passes in or out of the walls of the cylinder. Such curves are known as adiabatic curves, and

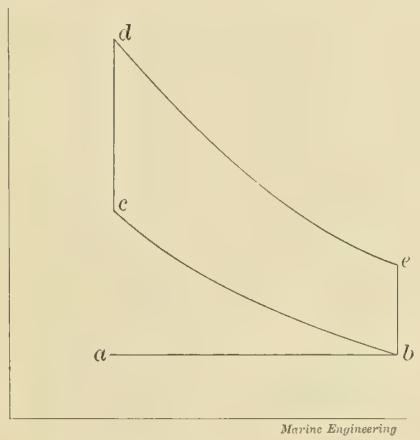


FIG. 2.

for a perfect gas are represented by an equation having the form:

$$p\,v^{1.4} = p_1 v_1^{1.4} \qquad (1)$$

We shall get exactly the same efficiency if we consider that heat is added at constant volume from *c* to *d* and rejected at constant volume from *e* to *b*. The first is of course true, for heat is added during explosion only, according to our previous assumption. But of the heat added, some is changed into work, and the remainder is necessarily rejected. Our new assumption does not change the area of the diagram or the work done, and consequently the heat that would be rejected if the contents of the cylinder were cooled at constant volume till the pressure dropped to that *a b*, must be the same as the heat really thrown out in the exhaust.

Suppose that the temperature of the gas and air at *d* is represented by t_b; then the absolute temperature reckoned from the absolute zero of temperature will be,

$$(T_b = t_b + 460°.)$$

In like manner the absolute temperature at *c*, *d* and *e* will be represented by T_c T_d and T_e.

For convenience let us assume that there is one pound of working substance in the cylinder, then if the specific heat of the gas and air at constant volume is c_v the heat required to raise the temperature from T_c to T_d will be,

$$c_v (T_d - T_c) \qquad (2)$$

And again the heat required to be withdrawn when the air and gas are cooled from *e* to *b* is:

$$c_v (T_e - T_b) \qquad (3)$$

In reality we should consider that the specific heat of the products of combustion differs from that of the mixture of gas and air before explosion, and further we should take cognizance of the changes of volume due to chemical changes; but especially with weak mixtures of gas and air, these considerations have very little importance and may well be neglected.

Now we have already said that the heat rejected is equal to the heat supplied, less the heat changed into work. Conversely, the heat changed into work is equal to the difference between the heat supplied and the heat changed into work. Therefore subtracting the expression (3) from (2) we have for the heat equivalent of the work done,

$$c_v (T_d - T_c) - c_v (T_e - T_b), \qquad (4)$$

and the efficiency, which is obtained by dividing this quantity by the heat applied is:

$$e = \frac{c_v (T_d - T_c) - c_v (T_e - T_b)}{T_d - T_c} = 1 - \frac{T_e - T_b}{T_d - T_c} \qquad (5)$$

But the volume of one pound of perfect gas is directly proportional to the absolute temperature and is inversely proportional to the absolute pressure, that is:

$$\frac{p\,v}{T} = \frac{p_1 v_1}{T_1} \qquad (6)$$

Dividing equation (1),

$$p\,v^{1.4} = p_1 v_1^{1.4}$$

by equation (6) term by term we have:

$$T\,v^{1.4-1} = T_1 v_1^{1.4-1} \qquad (7)$$

or

$$T\,v^{0.4} = T_1 v_1^{0.4} \qquad (8)$$

Applying equation (8) to the diagram represented by Fig. 2 we have:

$$T_d v_d^{0.4} = T_e v_e^{0.4} \quad (9)$$

and

$$T_c v_c^{0.4} = T_b v_b^{0.4} ; \quad (10)$$

but $v_d = v_c$ and $v_e = v_b$, consequently dividing equation (9) by equation (10) term by term we have:

$$\frac{T_d}{T_c} = \frac{T_e}{T_b} \quad (11)$$

$$\therefore \frac{T_d - T_c}{T_c} = \frac{T_e - T_b}{T_b} \quad (12)$$

$$\therefore \frac{T_b}{T_c} = \frac{T_e - T_b}{T_d - T_c} \quad (13)$$

By means of equation (13) we may reduce the expansion for efficiency from (5) to

$$e = 1 - \frac{T_b}{T_c} \quad (14)$$

But equation (10) gives,

$$\frac{T_b}{T_c} = \left(\frac{v_c}{v_b}\right)^{0.4} \quad (15)$$

so that our final expression for efficiency becomes,

$$e = 1 - \left(\frac{v_c}{v_b}\right)^{0.4}$$

The expression for the efficiency indicates just what is shown by the table of results of tests on Otto engines, i.e., that the efficiency is increased by reducing the clearance or explosion space, and thereby increasing the compression before explosion.

Suppose for example the clearance is one-third the piston displacement, so that u_c is one-fourth of u_b; then the efficiency is,

$$e = 1 - \left(\frac{1}{4}\right)^{0.4} = 0.43.$$

This corresponds very nearly to the third case in the table of tests on Otto engines.

When gas engines were first made the pressures realized in the cylinder, and especially the sudden rise of pressure were looked upon as difficulties; now that we are accustomed to using high pressure in steam engines, gas engines and air compressors, and understand both how to provide for such pressures, and the advantages to be attained from them, the tendency has been to continually increase the compression before explosion, and thereby increase the economy of the engine.

New German Transatlantic Liner.

The Vulcan Company, of Stettin, has secured the order for a new Atlantic steamer for the Hamburg-American Company to excel in speed every liner afloat, the trial-trip speed guaranteed being 23 1-2 knots on the measured mile, and 23 knots on the Atlantic, says Engineering, London. The vessel will be between 680 ft. and 690 ft. long over all; but the new White Star liner Oceanic, now building, is 704 ft. over all. The North German Lloyd ship "Kaiser Wilhelm der Grosse," is 625 ft., and her consort, "Kaiser Friedrich," 580 ft. The "Campania" and "Lucania" are 622 ft. long. The breadth, however, will not be much greater than these ships, being 66 ft. 6 in.; while the "Kaiser Wilhelm der Grosse," although over 60 ft. less in length is only 6 in. less in beam. The new ship is therefore exceptionally long for her breadth. The twin-screw engines, which are to develop a collective horse power of 36,000 indicated, are to be of the quadruple-expansion type. The two low pressure cylinders will drive the second and third cranks, the forward and after crank being actuated by tandem cylinders. This arrangement, it is believed, will give the best balancing arrangement, and the least twisting strain on the crankshaft. The boiler installation will not differ materially from that in the "Kaiser Wilhelm der Grosse," which was built by the same firm at Stettin, but for the competing company, the North German Lloyd. There are in her twelve double-ended and two single-ended boilers; but the boilers in the new ship will be worked with Howden's or Ellis & Eaves' draft.

Spanish Battleship "Pelayo."

The "Pelayo" is the only battleship possessed by Spain, and certainly a very formidable vessel, all the more so because she has just received a new and powerful armament at La Seyne, where she was also fitted with new machinery, says the *Navy and Army*, London, to which we are indebted for the excellent view of the vessel and also this description. Upon a displacement of 9,900 tons she has her main armament disposed on the French system—a system, by the way, now apparently abandoned.

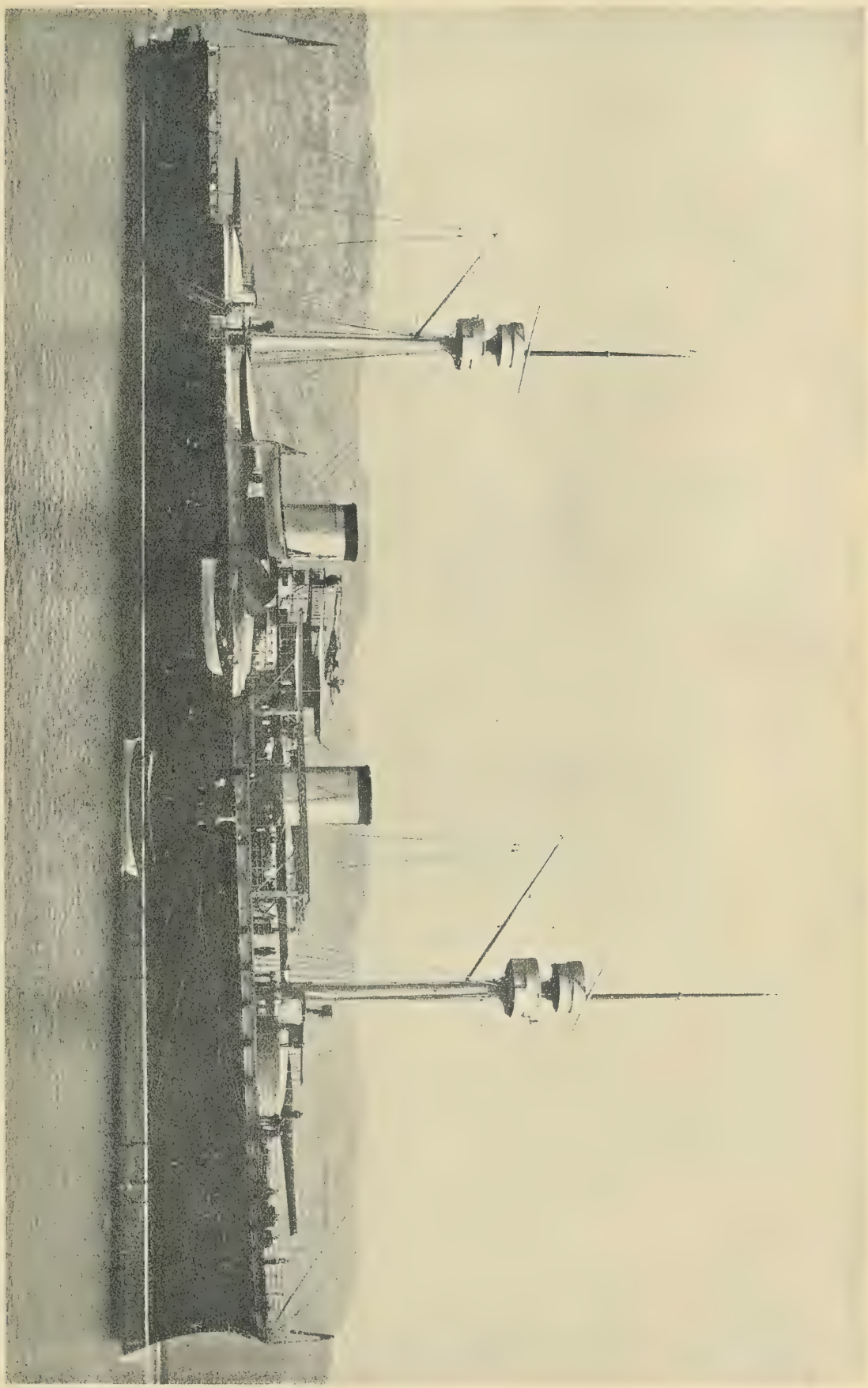
The four heavy guns are disposed singly in barbettes, of which one is forward, the second aft, and the others sponsoned on each broadside.

The advantage claimed for this arrangement is that of not putting too many eggs in one basket, in case a turret should chance to be disabled.

When the ship was built, she was armed with 12.5 in. Hontoria guns in the principal turrets, and 11 in. guns in the others. This arrangement has been changed, and she is now fitted with the new Canet 9.4 in. 22 ton gun, which will perforate 30 in. of steel at the muzzle, and which is much more powerful than the heavier predecessor.

The ship also mounts a very large quick-firing armament, and is protected by a complete compound belt, with a maximum thickness of 17.7 in., a 3.5 in. deck, 15.7 in. bulkheads, and 11.8 in. of steel on the barbettes.

[We understand that the new quick-firing armament consists of nine 5.5 in. rapid-fire guns. The "Pelayo" is 330 ft. long; 66 ft. beam, and has a draught of nearly 25 ft. She is fitted with torpedo tubes. With natural draught she developed 6,800 I. H. P. and a speed of 14 knots, and with forced draught 9,400 I. H. P. and 16 knots. Her coal capacity is about 800 tons, which would carry her about 5,000 miles at 12 knots speed.—Ed.]



SPAIN'S ONLY BATTLESHIP THE "PELAYO."—HEAVILY ARMORED AND POWERFULLY ARMED WITH HIGH-POWER GUNS.

(Photograph by M. Bar, Copyrighted by George Newnes, Ltd., London.)

NOVEL TYPE OF TOWING STEAMERS AND BARGES FOR SERVICE ON THE YUKON.

Eight new boats for the Yukon are building at the Crescent Ship Yard, Elizabethport, N. J., of which, as is well known, Lewis Nixon is the proprietor. They are for the Empire Transportation Co., to be run in connection with the Pacific coast line of that company, which was described at length in our March issue. The river fleet comprises two steam tugs, two passenger barges, and four freight barges. The boats will operate in two fleets, each consisting of one tug, two freight barges, and one passenger barge.

In the design of these boats full advantage has been taken of experience gained with the light-draught gunboats, Sheikh and Sultan, built in 1897 by Yarrow & Co., of London, for the Egyptian Government, on designs by Sir William White.

The general arrangement of the tugs is shown in the illustration on page 15. Their dimensions are: Length over all, 80 ft.; breadth, 32 ft.; depth, 5 ft. 6 in.; draught, 2 ft. 6 in.

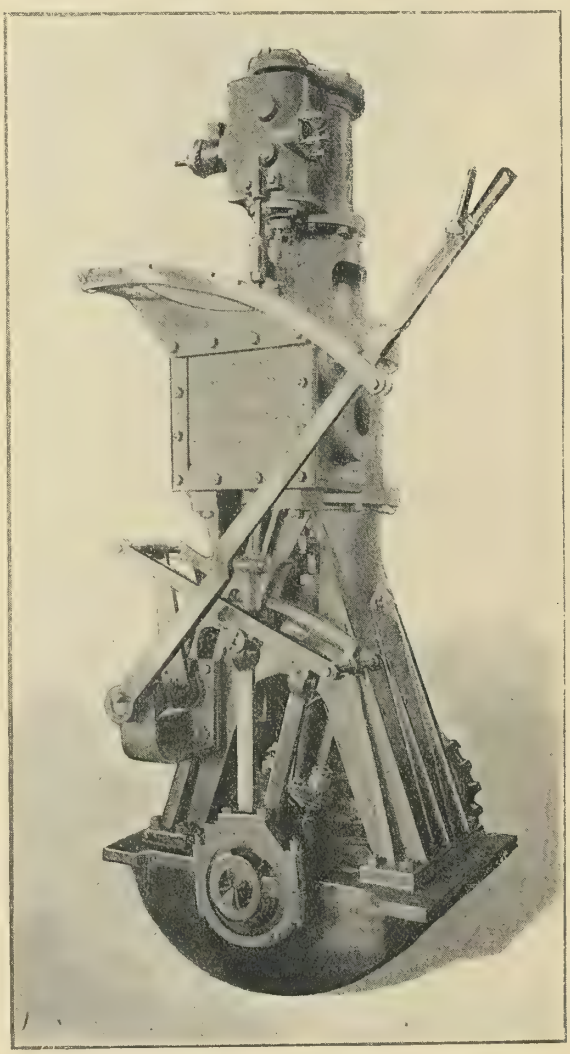
Each tug is composed of eight separate pontoons, which will float separately, and when joined together form one complete molded hull. The very complete midship section, which we publish with this article, gives a correct idea of their construction. The three keelsons shown in the midship section are built up of web framing, the opening shown at the middle of each being closed by a plate, to which the angle irons shown are riveted.

The construction of the two after pontoons calls for special remark. Each tug is to be propelled by six screws. For each of these an entirely independent waterway is worked in the bottom plating of the two after pontoons. The illustration of the general arrangement of the tug shows these tunnels and they can be plainly seen in the photograph on page 13. The frames of the two pontoons, shown in the drawing by broken lines, are worked to the exact section of the tunnels by their planes, except the frame crossing the stern tube. It is arched over the latter. The frames of these two pontoons, therefore, act as girders in stiffening and strengthening the propeller tunnels.

The bow pontoons are built with transom framing similar to that used in the construction of sterns in ordinary merchant practice.

The pontoons are to be tied together by 7-8 in. bolts spaced 6 in. apart all around the angle irons worked on the outside edges of the bulkheads forming the forward and after ends of each pontoon, and by butt-straps bolted outside the hull just below the yellow pine deck stringers shown in the midship section on page 14. These butt-straps are 36 in. wide, 7 ft. long, and 1-4 in. thick. The pontoons can be put together afloat by first filling the bolt holes below the water line with wooden plugs, and then replacing them, one by one, by the bolts.

The machinery equipment of each tug will include three Roberts safety water-tube boilers of 335 H. P. each, carrying steam of 200 lbs pressure. The engines will take full boiler pressure, there being no reducing valves. The combined grate surface of the three boilers will be 100 sq. ft., and the heating surface about 3,000 sq. ft. Each tug has room for 60 tons of coal in her bunkers, and the first barge of each tow will carry 200 tons more. The tug can be coaled directly from the barge through chutes. The ordinary water of the Yukon river cannot be used for boiler feed, being too full of clay and silt. A surface condenser will be used, but some feed makeup will, of course, be required, so fresh water will be carried in one pontoon of each tug. The streams emptying into the Yukon all along the route of these vessels are clear, so for some distance directly below their mouths the feed reserve can be replenished from the river. To enable the boilers to burn wood as well as coal the boiler casings are made of two layers of



TYPE OF ENGINE FOR YUKON BOATS.

asbestos board with an air space between, and the bottom row of tubes is raised higher above the grates than usual.

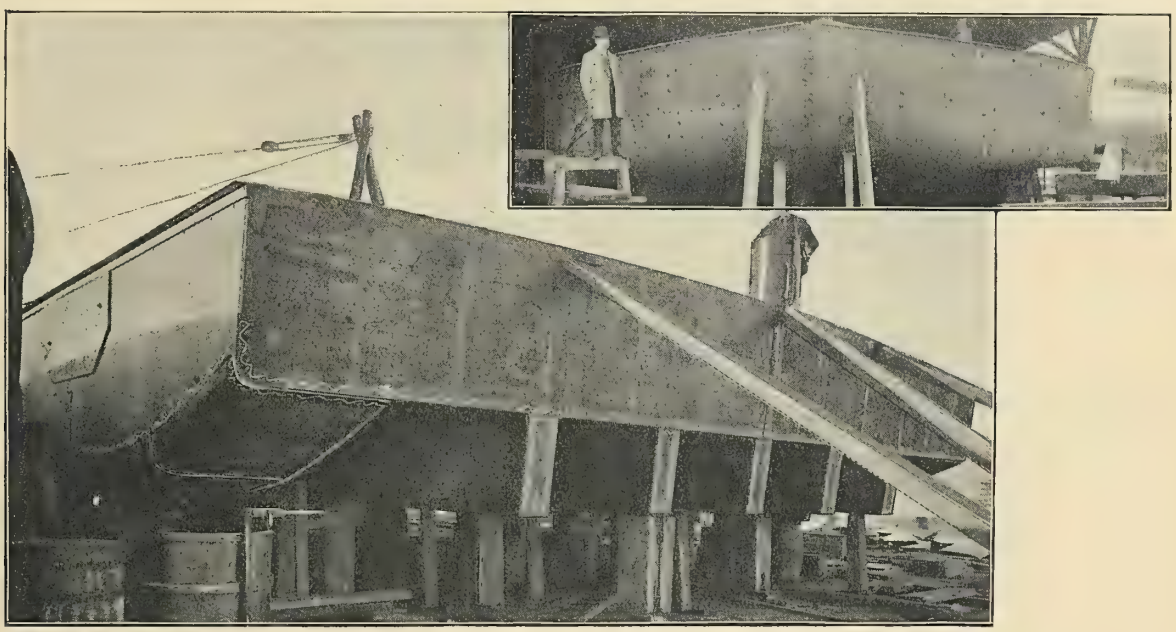
The drawing of the general arrangement of the tug shows the arrangement and location of the engines.

Each screw is driven by a separate engine of 167 I. H. P. Each engine is a vertical, compound, tandem, with the H. P. cylinder on top. The main deck comes about the middle of the L. P. cylinder. The dimensions are: H. P., 8 in.; L. P., 17 in.; stroke, 10 in. Each rests on a bed plate fastened to special keelsons, worked for the purpose. The general appearance of the engines is shown in the engravings on page 12. The H. P. cylinder has a piston valve, and the L. P. a slide valve. The cylinders are unjacketed. Each engine has a double bar Stephenson link and hand reversing lever, which is operated from the main deck. All six engines exhaust into the in thirty days. Both requirements were fulfilled.

Notwithstanding the high steam pressure used, compound engines were adopted instead of triple-expansion, partly because of lower first cost and shorter time needed for construction, but principally because of their greater simplicity and fewer working parts and consequent fewer repairs and greater ease of making the same.

The propeller shafts have brass sleeves shrunk on and secured by set screws, to form the rubbing surfaces in the stern tube and strut bearings. According to the usual fresh-water practice the propeller shafts will have no protection outside the bearings except paint.

Each stern tube has a canted flange cast on it, which bolts to the inclined forward surface of its propeller tunnel inside. The removal of the stern tube stuffing box gives access to the stern tube bearing, which is made in longitudinal halves to facilitate removal. The tugs can be trimmed by



PHOTOGRAPHS SHOWING BOW AND STERN OF YUKON RIVER BOATS.

top of one surface condenser, set against the forward engine-room bulkhead below the main deck. The cylinders are of cast iron, and the piston rods, eccentrics, crank shafts and motions are of cast steel, furnished by the American Steel Co., Thurlow, Pa. The cross heads are of phosphor bronze. The shaft couplings are of cast iron, shrunk on and secured by keys. Each crank shaft has on it three thrust collars abaft the cranks, and the coupling at its after end is enlarged into a jacking wheel. The engines jack by hand. In addition to the twelve engines for service there are two complete spares. All parts of all fourteen engines are interchangeable. The engines were designed and built by Samuel S. Moore & Sons Co., Elizabethport, N. J. The order for the engines required all fourteen to be complete in sixty days, and one to be complete the head sufficiently to allow any stern tube bearing to be shifted while afloat.

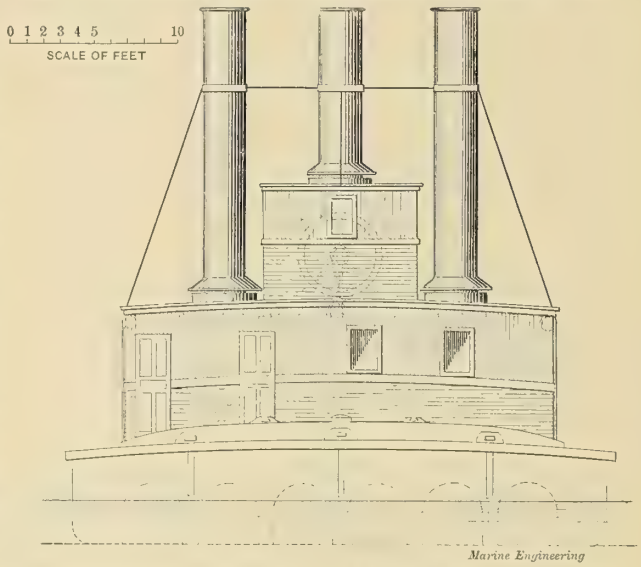
The propeller strut bearing is also made in longitudinal halves for easy removal. The struts will be merely bolted, instead of riveted, to the roofs of the tunnels for convenience in removal.

The propellers are 40 in. dia., of cast iron, with the hub and blades on one piece. There are four blades of large area, the projected area being about 50 per cent. of the circle swept by the tips of the blades less the projected area of the hub. Each blade is nearly a trapezoid, with the longer of the parallel sides at the periphery. The edges of each screw tunnel are well below the water line, so that each tunnel forms an air tight compartment hermetically sealed by the outside water. The action of the screw gradually pumps the air out of the tunnel, and the atmospheric

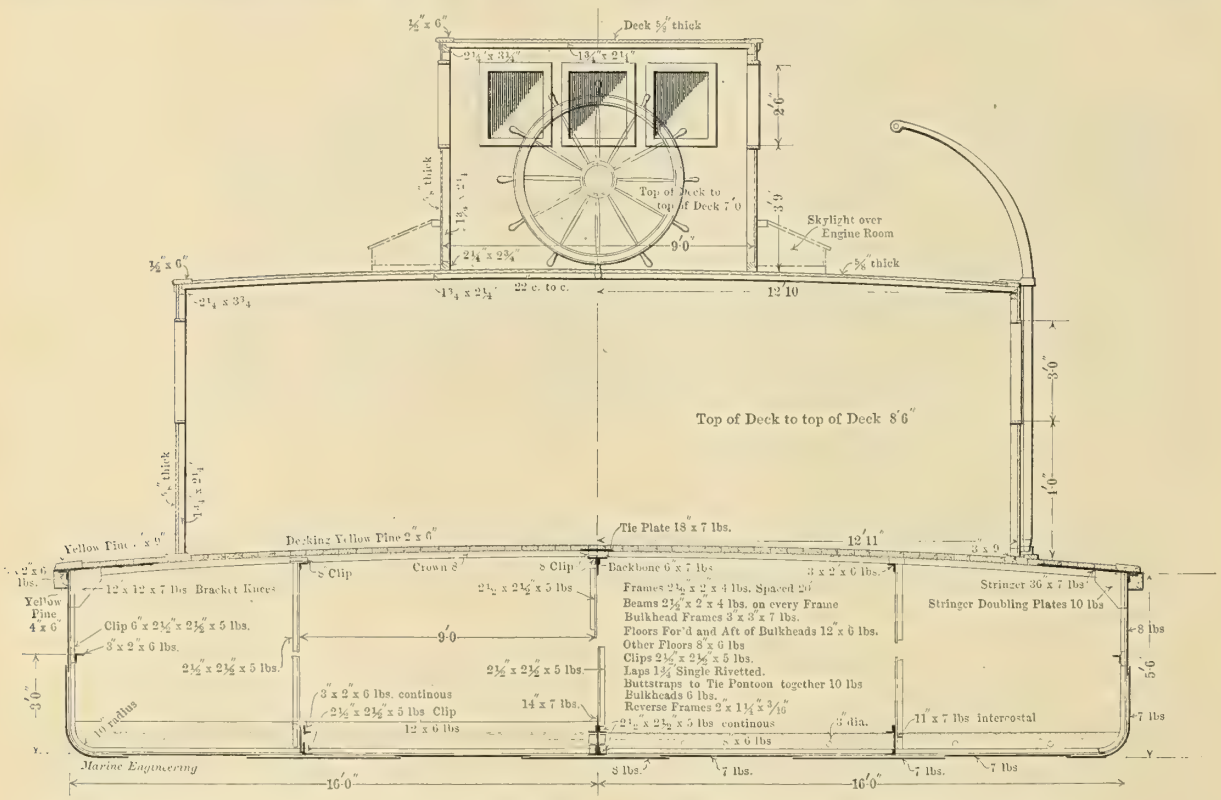
pressure at the same time raises the water in it, until the tunnel is finally full and the screw works in solid water, notwithstanding that under normal conditions it projects one foot above the water line. The propellers will have about the ordinary efficiency in spite of the great friction created by the walls of the tunnel, because the centrifugal loss will be largely done away with by confining the propeller race in the tunnel. With the "Sheikh" and the "Sultan," which were 145 ft. long, and 24 ft. 6 in. beam, Yarrow & Co., on a trial at a draught of 1 ft., 11 1-2 in. obtained a speed of a trifle over thirteen miles an hour with twin screws more than half above the water line and working on this principle.

Mr. Nixon estimates the speed of his Yukon boats as twelve miles an hour for the tug alone, and nine miles an hour for the tug and tow. The tips of the propeller blades run 2 in. above the bottom of the hull, and above the propellers are entirely enclosed by the hull, so that there is little risk of injury to them, but twenty-four spare ones are provided for the two tugs. Each tunnel has a manhole right on top, closed by a cast plate of section so arched that it forms a perfectly fair surface with the interior walls of the tunnel. When this plate is removed, the water in the tunnel falls to the level outside, and the tug while afloat can be trimmed enough by the head to allow work to be done to any screw, strut, or strut bearing, even to the extent of removing it and putting in a new one.

In the "Sheikh" and the "Sultan" this system of propulsion was adopted because of the military advantages which it offered, especially in that it permitted the propelling machinery and its attendants to be more sheltered than they could be with paddle wheel machinery. In these Yukon boats it was adopted principally in order to save weight. Their engines will run at from 200 to 225 revolutions per minute, as against



END ELEVATION SHOWING TUNNELS FOR THE SIX PROPELLERS.

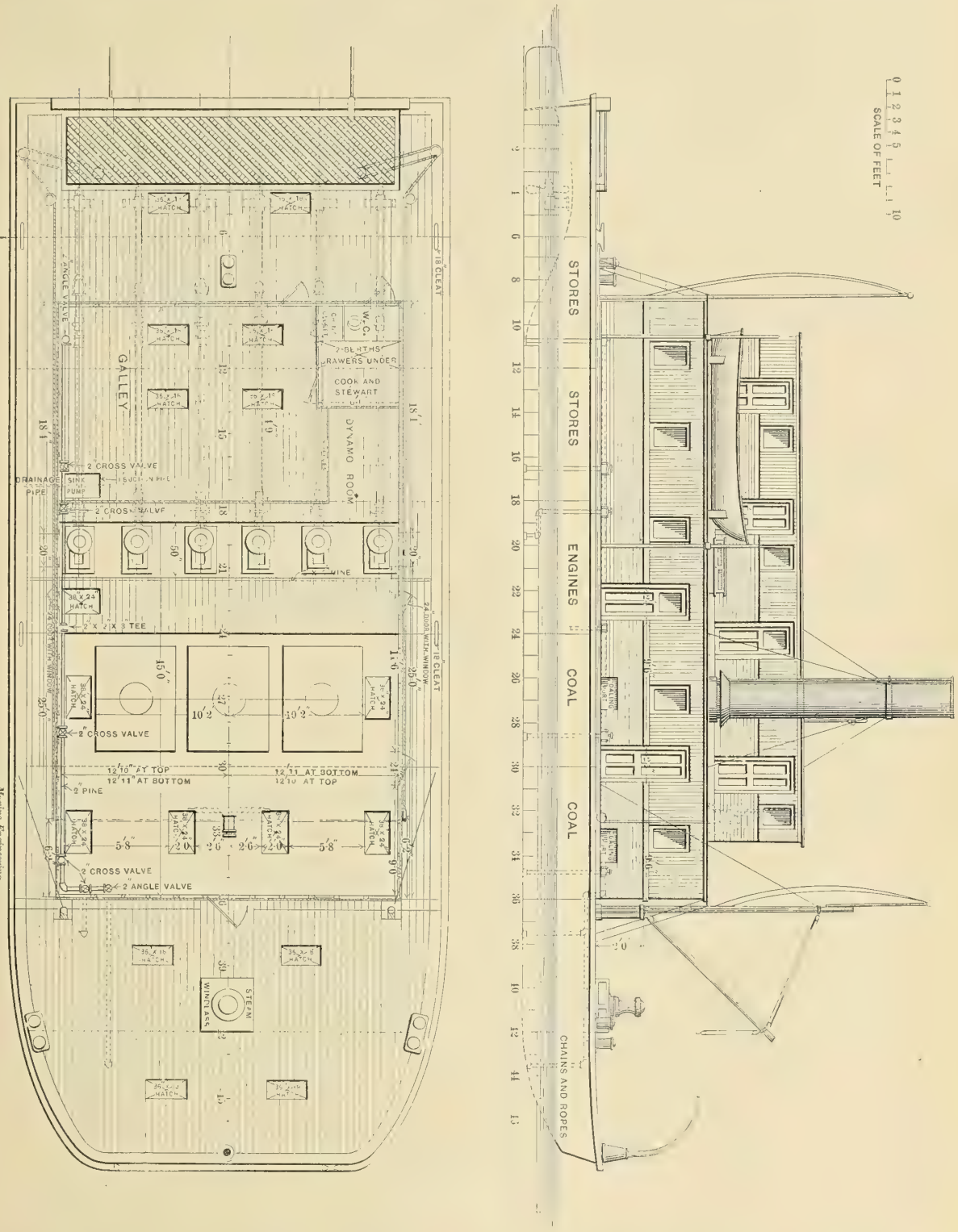

Deck 5/8" thick
Top of Deck to top of Deck 7'0
Skylight over Engine Room
5/8" thick
22 c. to c.
12'10
Top of Deck to top of Deck 8'6"
Tie Plate 18" x 7 lbs.
12'11"
Yellow Pine 4 x 6"
Decking Yellow Pine 2" x 6"
8 Clip
Crown 8
Backbone 6" x 7 lbs
12 x 12 x 7 lbs Bracket Knees
Clip 6" x 2½" x 2½" x 5 lbs.
3" x 2" x 6 lbs.
2½" x 2½" x 5 lbs.
9'0
3" x 2" x 6 lbs. continous
2½" x 2½" x 5 lbs Clip
12 x 6 lbs
14" x 7 lbs.
Frames 2½" x 2" x 4 lbs. Spaced 20"
Beams 2½" x 2" x 4 lbs. on every Frame
Bulkhead Frames 3" x 3" x 7 lbs.
Floors For'd and Aft of Bulkheads 12" x 6 lbs.
Other Floors 8" x 6 lbs
Clips 2½" x 2½" x 5 lbs.
Laps 1¾" Single Rivetted.
Buttstraps to Tie Pontoon together 10 lbs
Bulkheads 6 lbs.
Reverse Frames 2" x 1½" x 3/16"
2½" x 2½" x 5 lbs continous
3" x 2" x 6 lbs.
Stringer 36" x 7 lbs
Stringer Doubling Plates 10 lbs
11" x 7 lbs intercostal
8 lbs
7 lbs
5'6"
3'0"
10" radius
Marine Engineering
8 lbs.
7 lbs.
7 lbs.
16'0"
16'0"

SECTION SHOWING FLOORS FOR'D AND AFT OF BULKHEADS — SECTION SHOWING INTERMEDIATE FRAMES

MIDSHIP SECTION OF YUKON RIVER TOWBOAT SHOWING METHOD OF CONSTRUCTION.

about 40 revolutions with a stern wheel. By using a compound stern wheel engine a fair economy would be obtained, but it is expected with these engines to do even better. This, combined with the great saving of engine weight, will enable enough coal to be carried for the round trip, so that these fleets will be relieved of the necessity of tying up during the trip to coal ship. Besides there is much greater security against break-down, as the complete wrecking of an engine would disable only one-sixth of the power. This system of propulsion also offers

GENERAL ARRANGEMENT OF YUKON TUGS BUILT BY LEWIS NIXON, CRESCENT SHIPYARD, ELIZABETHPORT, N. J.



great advantages in handling. With the "Sheikh" and the "Sultan" it was found that from full speed ahead they could be brought to rest in about two lengths. Such quickness is of the utmost value in navigating shallow rivers, the beds of which are continually changing, especially in lonely waters like the Yukon where a vessel aground would find it difficult to get assistance.

Each tug will be provided with one centrifugal circulating pump, a Worthington independent vertical twin-cylinder air pump, and vertical Admiralty feed pumps. There will also be a full outfit of fire and bilge pumps, one powerful steam capstan, and two cargo derricks, to each tug. Each tug will also have an electric light plant consisting of one General Electric direct-connected lighting set, supplying current to sixty lamps and one search light. The voltage will be 110. The search lights are building by the Philadelphia Electro-Dynamic Co.

The first two barges of the tow will be for freight, and the last one for passengers. The dimensions of both freight and passenger barges are: Length, 100 ft.; breadth, 35 ft.; depth, 5 ft. 6 in.; draught, 2 ft. 6 in.; and each barge is made up of ten pontoons. The passenger barges will have fixed berths on the main deck and state rooms on the upper deck. Otherwise their arrangements are well enough shown by their drawings which we publish herewith. Each fleet can carry 800 persons and 2,000 tons of freight.

The Empire Transportation Co.'s steamer Conemaugh is now on her way around to the Yukon. She will be anchored three or four miles out at St. Michael's as a repair ship for the line. She will have complete machine and blacksmith shops capable of handling as large work as will be necessary.

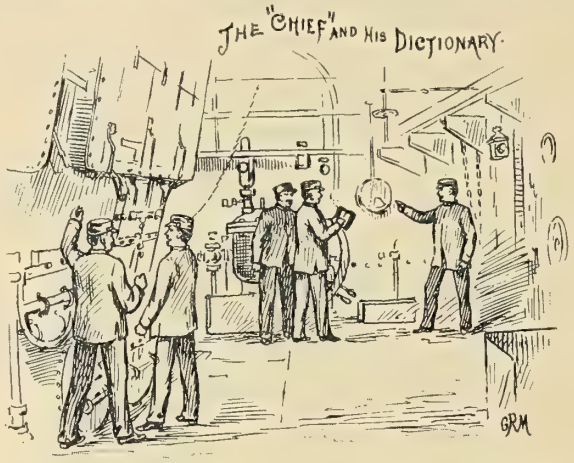
One tug will be completed and put into the water here, and will have a trial trip. The machinery will then be removed, and the cabins and pontoons taken apart. The two passenger barges were shipped April 4, two more barges followed about April 18, and the entire fleet was on the way early in May. The cabins are built in sections and assembled at the yard. The cabin sections, pontoons, and machinery will be shipped by rail to Seattle and thence by steamer to St. Michael's. Sea going vessels there must anchor at least a mile and a half out, and the system of construction adopted allows the pontoons to be simply lowered overboard, floated into place, and bolted together, without going to the great expense and loss of time of taking them ashore, erecting them on ways, riveting together, and launching.

The construction of the vessels was under the inspection of Captain Peter Bloomsburg, of H. Bloomsburg & Co.

The first trip on the Yukon will be made as soon as the ice gets out, probably about June 20. This will be a link in a direct line from Europe to the Klondike.

FIRST AND LAST CRUISE OF THE UNITED STATES CRUISER AMAZONAS.

A short time previous to the outbreak of the present war with Spain the U. S. S. San Francisco was ordered to proceed with the utmost despatch from Lisbon, Portugal, to Gravesend, England, to place a crew on the cruiser "Amazonas" recently purchased by the United States from the Brazilian Government.



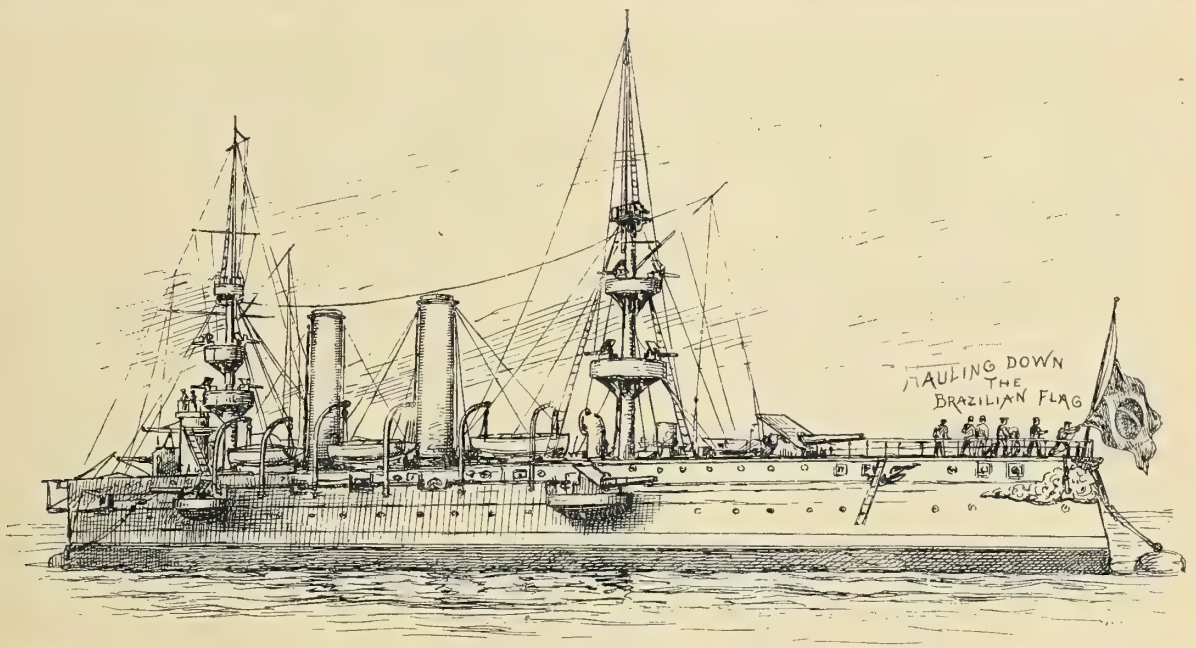
On arrival we found the Stars and Stripes already floating over the cruiser, she having been placed in commission by Lieutenant J. C. Colwell, Naval Attaché at London that same forenoon.

The transfer of a man-of-war from the flag of one nation to that of another in the port of a third power is a very unusual proceeding, though here it was marked with but little ceremony.

THE "MAJOR" KEEPS WARM.

The Brazilian crew was mustered aft on the quarter deck. Briefly the commanding officer expressed his regret at losing his ship for which he had waited *so many years*. This sad duty, he said, became a pleasure, for by this act his government was able to show its friendship to a power which recently had so signally shown its friendship to his country.

The Green and Yellow ensign was then hauled down and in its place was hoisted the Red, White and Blue, and eight officers and ninety-five enlisted men were transferred from the "San Francisco" to the new ship. Placing a ship in commission under the best of circumstances is no sinecure, and in this one felt like a cat in a strange garret. A hasty tour around the ship showed that the names of the various compartments and all instructions on signal gear were in Portuguese, and everything was locked and the keys bunched promiscuously on the cabin table. There was an immediate council of war at which the executive officer presided, and with the aid of certain plans, and the Portuguese dictionary of the Chief Engineer, a successful attack was made upon the ship's compartments. This was none too soon, for already Jack, forward, had formed a boarding party and knocked in the head of a stout puncheon of liquor left behind by the



Brazilian sailors in their retreat. This was speedily carried aft and subsequently it proved to have wonderful thermal properties. Like most British cruisers no means of heating the living spaces had been provided, and on deck we were exposed to real Lunnon weather, drizzle and sleet by day and frost by night, and between decks everything was kept damp by the condensation of moisture on the steel of the ship. The only way to keep warm during the day was to keep moving, especially as we were accustomed to the fine weather of the Riviera. At dinner we gathered around the tables in regulation overcoats, with collars, and, out of respect to our surroundings, trousers turned up. It was at night, however, that the bravery of our fellows was shown, for it required rare courage to plunge into the cold beds and rarer still to turn out. "El Medico," as the Portuguese label styled him, saved lives and earned the good will of his messmates by discovering that a portable electric lamp was as good as a hot water bottle. The "Major," who had two lamps, was considered the luckiest man aboard, as he enjoyed the unusual sensation of heat penetrating the soles of his feet and creeping up his spinal column at the same time. A requisition was made on the Paymaster for two of the largest stoves in all England, and visions of huge crackling logs filled our minds. When the stoves appeared, our executive swore they were only drummers' samples, as they bore about the same proportion to an old fashioned base burner as the British Isles do to the United States. While they were being set up our Chief Engineer did some rapid figuring on the ratio of grate surface to heating surface, and there was no scarcity of firemen to carry his theory into practice. What the stoves lacked in size was compensated for by the enthusiasm of the stokers, who worked watch and watch at a 30-knot gait all through the voyage. But other troubles were coming. Fresh water got so scarce that we couldn't afford a chaser, and the more the engineers distilled the less there was in sight. Some one suggested that the weight of water distilled was forcing it through the bottom, and an ensign was sent into the bilges to hunt for a hole. Before he crawled out a list to starboard caused an investigation that showed some of the double bottoms were filled with fresh water. How it got there even the Chief Engineer with his invaluable dictionary couldn't tell.

After ten days of constant hard work all the coal and ammunition was on board, and on March 27, with a homeward pennant 170 ft. long, the "Amazonas" followed the motions of the flagship and was soon headed for the western

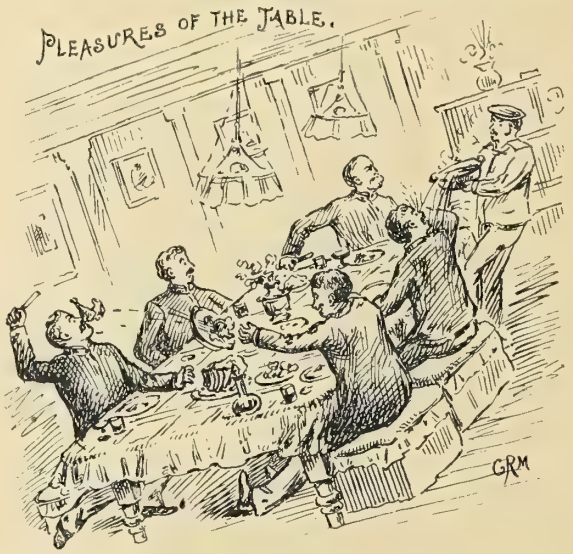
ocean. The first few days out, while passing through the channel, the weather was fine with smooth seas. Running at what was an economical speed for the "San Francisco," about 265 miles a day were logged, and it was calculated that we would reach New York about Easter day. But there are some things not down in the regulations, and on April 4 we ran into a north-

west gale which continued with but slight remissions for a week.

The "Amazonas" has a low freeboard, and with even a moderate sea running, the decks are constantly wet. As the storm increased the seas would sweep down the deck and bring up against the steel bulkhead of the wardroom, which opens on the quarter deck by two sliding steel doors. One evening as our executive stepped in in his oilskins he brought with him a generous portion of the Atlantic, and for a time the ward room was an improved swimming tank, with several amateur divers contesting for the driest spots. An usually heavy roll (26° to port and 40° to starboard) deposited about everything movable, including bureau drawers and contents, ink bottles, and officers of various grades on the deck in one confused heap. It was several days before the Chinese laundry appearance of the wardroom wore off. Meanwhile the gale was increasing and making things pleasant on deck. One tremendous sea came over the forecastle, nearly carried the Captain overboard, stove in and partially carried away the starboard life boat, wrecked the hand steering wheel and expended the last of its strength on the wardroom doors. The starboard one slid open and again there were impromptu aquatic sports. If there was one thing our boat excelled in it was the unexpected in motion, for just where you expected it to be is exactly where it was not. We all took such an interest in these demonstrations that meals were forgotten until exhaustion made eating a necessity if not a pleasure. One gunnery enthusiast took occasion to deliver illustrated discourses on the flight of projectiles whenever we sat down to meals. Toward the end of the voyage provisions ran low and cold corned beef, hardtack, prunes and coffee were made into a wonderful variety of combinations, which though spelled differently tasted alike. All hands were greatly disappointed when on the ninth the flagship signaled to change course and proceed to Halifax, a change of plan necessitated by a shortage of coal on the flagship.

While at sea and cut off from all news of the prospective war we gradually thought and talked less and less about it. But as we approached land our curiosity became more and more excited, and when the pilot and health officer boarded us they were rushed for news of the war. We got a lot of pleasant attention, too, from the good folk of Halifax. The general sentiment was well expressed in the words of a small boy in a boat, who was busy grabbing at the elusive bladder tied to the end of our homeward bound pennant. When hailed he replied: "Lick them Spanish, and while you're about it, lick 'em good—for us."

The run from Halifax to New York gave a chance to clean up and on April 15 we dropped anchor off Tompkinsville. On the eighteenth we went up to the Navy Yard between lines of screeching tugs and ferryboats, and the cruise of the "Amazonas" was finished. Renamed, remanned and partially reconstructed, she is now,



under the name of the "New Orleans," one of the Flying Squadron, and in the fight which now seems so imminent she will undoubtedly prove herself a great acquisition to the United States Navy.

Additional List of Auxiliary Vessels.

We publish this month a list of vessels added to the navy which were not included in the list published in May. Not all the particulars concerning the vessels are obtainable, but the table has been made as complete as possible with proper regard for accuracy. We take occasion to call attention to some changes which should be made in the table published in May. The

WARSHIPS AND AUXILIARY VESSELS RECENTLY ACQUIRED BY THE UNITED STATES NAVY BY PURCHASE, CHARTER OR TRANSFER (*SECOND TABLE*).

Old Name and Date.	Old Class.	Length.	Breadth.	Depth.	Draught.	Displacement. Tons.	Horse Power.	Speed. Knots.	Where Built.	Hailing Port.	Former Owners.	New Class.	New Name.
		ft. in.	ft. in.	ft. in.	ft. in.								
Abarenda, '92	Steel freighter	314	42	26	.. :	2,123 gross	250 N.	8	Newcastle-on-Tyne.	Newcastle.	Graham S. S. Co.	Collier	Abarenda
Active, '88	Tug	100	22 6	12 6	.....	174 "	500	.....	San Francisco.	San Francisco.	J. D. Spreckels & Bros. Co.	Tug	Active
Aileen, '96	Yacht	140	20	15	8 9	151 net	.....	16	John Roach.	New York.	Richard Stevens.	Aux. gunboat	Aileen
Albatross, '82	Fish steamer	200	27 6	16 9	12	639 gross	289	9	Wilmington.	.....	U. S. Fish Commission.	Gunboat	Albatross
Algonquin, '98	U. S. Rev. cutter	205	32	17	11 6	906	2,500	18	Globe Iron Works.	Great Lakes.	U. S. R. C. S.	Aux. gunboat	Accomac
Celtic King, '91	Steel meat and cargo steamship	371 8	42 2	27 2	.....	3,738 gross	360 N	12	Workman, Clark & Co. Belfast.	London.	Federal S. N. Co.	Supply ship	Celtic
C. G. Coyle	Iron tug	91 4	21	10 3	.....	152 "	.....	.....	.....	.....	.....	.....	Choctaw
Chatham, '84	Coast liner	270	42	34	.....	2,729 "	1,800	.....	Philadelphia.	Baltimore.	Merchants' & Miners' T. Co.	Repair ship	Vulcan
Corsair, '91	Steam yacht	204	27	16 5	13	560 "	1,900	18	Neafie & Levy.	New York.	J. P. Morgan.	Aux. gunboat	Gloucester
C. P. Patterson, '83	Survey steamer	175	27 3	.....	14 2	718	350	9	Brooklyn, N. Y.	Pacific Coast.	U. S. Coast Survey.	.....	Patterson
Enterprise, '90	Tug	91 6	21	10	.....	124 gross	.....	.....	Camden, N. J.	.....	Hy. Brown.	Tug	Modoc
Fearless, '92	Steel tug	145	26	16	.....	400 "	1,200	.....	San Francisco.	San Francisco.	J. D. Spreckels & Bros. Co.	Tug	Iroquois
Felicia, '98	Steam yacht	142	20	11	6	.....	1,200	17	J. M Robins Co.	New York.	E. W. Bliss.	Aux. gunboat	Uncanoomuck
Fish Hawk, '79	Fish steamer	146 6	27	10 9	8 6	442 gross	.....	9	Wilmington, Del.	Wilmington.	U. S. Fish Commission.	Gunboat	Fish Hawk
Free Lance, '79.	Yacht.	109	20	10	7	90 net	600	16	Lewis Nixon.	New York.	F. A. Schermerhorn.	Aux. gunboat.	Free Lance
Gedney, '75	Survey steamer	140	23 8	10 4	6 9	174 gross	250	8	New York.	.....	U. S. Coast Survey.	.....	Gedney
Gresham, '97	Revenue cutter	205	32	17	11 6	906	2,500	18	Globe Iron Works.	U. S. R. C. S.	U. S. R. C. S.	Aux. gunboat	Gresham
Harlech, '97	Freighter	235 2	34 3	14 3	.....	1,282 gross	160 N.	.....	Sunderland.	London.	J. & C. Harrison.	Collier	Pompey
Hercules, '88	Tug	101 5	20 6	10 8	.....	142 "	.....	14	J. H. Dialogue & Son.	New York.	Standard Oil Co.	Tug	Hercules
Hortense, '93	Steel tug	102	21	9 6	.....	130 "	.....	.....	J. H. Dialogue & Son.	Galveston.	Galveston Cons. Co.	Tug	"
Illawawa, '96	Steam yacht	106 3	18 6	10 6	8 2	119 "	.....	13	Bath Iron Works.	Boston.	Eugene Tompkins.	Aux. gunboat	Oneida
Illinois, '73	Transatlant liner	343	43	32 1	25	3,126 "	1,200	10.5	Cramp.	New York.	Inter. Nav. Co.	Provision ship	Supply
John Dwight, '96	Steam Lighter	120	27 3	7 9	7	151 "	.....	.....	Roderwald & Co.	.....	.....	Lighter	Pawnee
Justin, '91	Steel freighter	277	39	18 2	.....	2,206 "	200 N.	10	Middlesboro.	London.	Eng. & Amer. Shipping Co.	Collier	Justin
Kingtor, '96	Steel freighter	310	44	20 5	.....	2 738 "	250 N.	9	Ropner & Son, St'kt'n.	London	J. Holman & Son.	Collier	Caesar
Louis McLane, '65	Side-wh'l rev. cut	163	28	11 2	6	315	410	10.5	Transf. from Navy '65.	Key West.	U. S. R. C. S.	Pilot & Scout	L. McLane
McArthur, '76	Survey steamer	115	20	.....	12	130 "	.....	.....	Mare Island, Cal.	Pacific Coast.	U. S. Coast Survey.	.....	McArthur
*Menemsha, '85	Freighter	304 3	38 8	26 5	.....	2,716 "	220 N.	.....	Newcastle-on-Tyne.	New York.	T. Hogan & Son.	Water ship	Iris
New York, '89	Transatlant. liner	560	63 2	39 2	23	13,300	20,000	21.8	Clydebank, Scotland.	New York.	Inter Nav. Co.	Aux. cruiser	Harvard
Paris, '88	Transatlant liner	560	63 2	39 2	23	13,300	20,000	21	Clydebank, Scotland.	New York.	In er. Nav. Co.	Aux. cruiser	Yale
Penelope, '93	Steel yacht	218	27	16	.....	541 gross	750	14	Leith, Scotland.	Boston.	H. E. Converse.	Aux. gunboat	Yankton
Pennwood, '92	Iron tug	101 8	21 8	11 3	.....	156 "	.....	.....	Sparrows Point, Md.	.....	J. R. Ford Trans. Co.	Tug	Powhatan
Philadelphia, '96	Pilot boat	140 8	25	14 6	12	300 "	700	15	Neafie & Levy.	Philadelphia.	Philadelphia Pilots.	Miscellaneous	Peoria
Restless, '87	Yacht	104	16	8 8	.....	104	55)	12	Houston & Woodbridge	Philadelphia.	H. W. Sibley.	Aux. gunboat	Restless
Right Arm, '91	Tug	124 4	27	10 5	.....	238 gross	.....	.....	Athens, N. Y.	New York.	.....	Tug	Pontiac
Southery, '89	Freighter	288	38 8	18 3	.....	2,068 "	1,000	9	Sunderland.	St. John.	T. E. Morrison.	Collier	Southery
Thespia, '95	Steam yacht	169	23 3	13	9 10	312 "	600	12	Cramp.	New York.	David Dows, Jr.	Aux. gunboat	Hist
T. P. Fowler, '83	Tug	97 6	24	11	.....	161 "	.....	.....	Newburg, N. Y.	Albany, N. Y.	.....	Water boat	Mohawk
Venezuela, '89	W. I. liner	303 6	40 2	27 9	19 6	2 843 "	2,500	15	Cramp.	Wilmington, Del.	Red D. Line.	Aux. cruiser	Panther
Vigilant, '83	Tug	107	21	12 8	.....	177 "	280	.....	Philadelphia.	San Francisco.	J. D. Spreckels & Bro. Co.	Tug	Vigilant
Viking, '83	Yacht	125 6	20 6	10 4	9	141 "	.....	13	John Roach.	New York.	Horace C. Hutchins.	Aux. gunboat	Viking
W. H. Brown, '97	Tug	156 8	28	17	13	833 "	2,000	17	F. W. Wheeler & Co. West Bay City.	Pittsburgh.	W. H. Brown.	Water boat	Piscataqua
Yorktown, '94	Coast liner	300	40	34	20	2,898 "	3,500	16	John Roach.	New York.	Old Dominion S. S. Co.	Aux. cruiser	Resolute
Yumuri, '89	W. I. liner	336 2	43 2	22 3	18	3,497 "	2,600	14	John Roach.	New York.	J. E. Ward & Co.	Arm'd transp't	Badger

*Formerly British S. S. Dryden.

Italian steam yacht Aegusa has not been acquired by the navy, negotiations for the purchase of this vessel not having been completed before war was declared. Owing to a typographical error the new names of the Morgan liners were not correctly given. These should be "El Rio," now "Dixie;" "El Sol," now "Prairie;" "El Sud," now "Yosemite." The tug Paoli, though examined by the board, was not purchased. Details regarding the armament of the vessels in their new classes cannot be given, as the government, for good and sufficient reasons, has prohibited the publication of such details. A number of vessels has been requisitioned by the War Department for the transport of troops.

ESTIMATED WEIGHTS OF MACHINERY, WITH FORMULAE FOR SCREW AND SIDE-WHEEL STEAMERS.—II.

BY PROF. GEO. R. M'DERMOTT.

Throughout the course of many years' experience in business life, the writer has gathered together the recorded detail weights of machinery of over 300 vessels, embracing almost all of the types to be found in both the warship and mercantile fields of service.

Some time ago I subjected this collection of data to a rigorous analysis with the object of arranging it in a form which would lend itself most readily to estimating purposes. Throughout these investigations, and in the arrangement of the information certain conditions were laid down and kept clearly in view, the chief aim being to devise a system, as little complicated as possible, by which estimates of weight could be made within as short a space of time as would be consistent with the degree of accuracy required in such work; the system to be so arranged as to furnish, at the same time, the weights in such divisions as would be convenient in making trim, strength and stability calculations of the vessels in which the machinery was to be fitted. With this in view, four leading divisons were fixed upon, viz.; (1) Engine-room weights; (2) boiler-room weights; (3) shafting weights; (4) propeller weights. In the first division (engine-room weights) it was found very early in the investigations that it would be necessary to split it up under two heads: Warship engines and mercantile engines, these heads being again subdivided as follows: Warship engines: (a) launches, pinnaces, torpedo-boats, destroyers, and torpedo gunboats; (b) battleships, cruisers, gunboats, and commerce destroyers with horizontal engines; (c) battleships, cruisers, gunboats, and commerce destroyers with vertical engines. Mercantile engines: (d) Launches, and other small boats; (e) steamers of all classes, including yachts; (f) side-wheel engines, oscillating; (g) side-wheel engines, diagonal. The engine-room weights include the main engines (excepting all shafting, bed plates, shaft bearings, caps, bolts, etc.), auxiliary engines, all pumps and connections, condensers, water in condensers and pipes, pipes in engine room, tools, workshop fittings, platforms, gratings, ladders, ventilator fans to engine room, etc. In the case of warships, the weights of steam steering engine and electric light machinery are included also.

The second division (shafting) was separated under two heads: Screw propelling shafting and paddle propelling shafting. The weight of shafting includes crank, line, thrust, and propeller shafts, engine bed plates, shaft bearings throughout, caps, bolts, etc.

The third division (boilers) was divided off under three heads: Main boilers, main boilers water, auxiliary boilers and water, the first two heads being subdivided into the following classes: Scotch boilers, navy or low cylindrical boilers, and locomotive boilers.

Boiler room weights include boilers and mountings, uptakes, smoke stacks, pipes within boiler room, forced or assisted draft arrangements and appliances, ventilating arrangements, ash hoists, stokehold plates, platforms, gratings, ladders, firebars, tools and utensils, all fittings and spare gear, water at working level.

The fourth division (propellers) was divided under two heads: Screw propellers, and side wheels, these heads being subdivided as follows: Screw propellers, detachable, 3 or 4 blades; screw propellers, solid propellers, 3 or 4 blades; side wheels, feathering floats; side wheels, radial floats. The weight of propellers includes weight of boss, blades, bolts and washers. (Cast iron or steel.)

Formulæ for Estimating Weights of Boilers Exclusive of Boiler Room Weights.

Scotch Boilers:	
Single ended	Wt. in tons=.0075N $[D^2 (L + 2) + HS] + 1.5N$.
Double ended	Wt. in tons=.0075N $[D^2 (L + 2) + HS]$
Navy Boilers:	
Single ended	Wt. in tons= .005N $[D^2 (L + 2) + HS] + 8$ N.
Double ended	Wt. in tons= .005N $[D^2 (L + 2) + HS] + 6.5N$.
Locomotive Boilers	Wt. in tons=.0075N $[D^2 (L + 2) + HS] - 1.5N$.

FORMULÆ FOR ESTIMATING WEIGHTS OF BEAM SIDE WHEEL ENGINES.

Beam Surface Condensing	Wt. in tons=.55 $(\sqrt{DL} - 10)$
Beam Jet Condensing	Wt. in tons=.64 $(\sqrt{DL} - 60)$

The weight of side wheels includes ribs, rings, floats, bolts, etc., complete; in the case of feathering floats, the weight of feathering gear is also included.

The detail weights were carefully collected under the different heads and subdivisions, the totals were then tested, tried, and measured on different bases separately and in combination before the formulæ presented were finally accepted as satisfactory. It is the writer's belief that it would serve no useful purpose to describe the details of the investigations, and he will content himself with presenting the formulæ as finally adopted.

The formulæ are given (February issue page 19), and an example is also given showing the method of application and the work involved in estimating the weight of machinery of the U. S. S. Olympia, see page 21 this issue.

In the writer's opinion the formulæ will give results not more than from 3 per cent to 5 per cent in error, allowing for a normal amount of spare gear. The formulæ have been built up on current practice, triple expansion engines, and boiler pressures from 150 to 175 lbs. It is interesting to note, however, that they give

a close approximation to the weights of compound engines and pressures of 80 to 100 lbs. This, it would seem, points to the fact that, although higher pressures involve greater strength, improvements in materials have followed right along the line of increased pressure, permitting the weight per unit of surface to remain constant.

Unfortunately, sufficient data is not at hand of quadruple expansion engines to allow of definite statements being made as to the probable increase in weight, but in a general way I think that an increase of about 5 per cent should be made on the engine room and boiler room weights as estimated by formulæ.

It is also very difficult to obtain reliable

ESTIMATED WEIGHT OF MACHINERY, U. S. S. OLYMPIA.

Engines.

Type	V. T.
No. of sets	2
Diam. H. P. cyl	49
" I. P. cyl	59
" L. P. cyl	92
Stroke	3.5

Propeller.

No. and diam. 2	14.75
Surface	68
No. of blades	3

Shafting.

	Length.	Diameter. Shaft.	Hole.
Crank	57.76	16	7.5
Thrust	38.88	15.75	7.5
Line	70.00	15.75	7.5
Propeller	78.00	16	7.5

Auxiliary Boiler.

Number	
Diameter	None.
Length	

Main Boilers.

	Type Scotch D. E.	S. E.
Number	4	2
Diameter	15.25	15.25
Length	21.25	10.96
Heating surface (1)	5659.7	2829.9
Tube diameter	2.25	2.25
" length	7.66	7.6
Furnaces, number	8	4
" diameter	3.25	3.25
Height of water	6	6

Engine-Room Weights.

$HP^2 = 42^2 =$ 1764
$IP^2 = 59^2 =$ 3481
$LP^2 = 92^2 =$ 8464

D 13709
L 3.5

(DL) 47981.5
Log. (DL) 4.681
3

4)14.043

Log. $(DL)^{\frac{3}{4}}$ 3.5108
$(DL)^{\frac{3}{4}}$ 3242
$.052n$ .104

Weight 337.16

Wt. of Propellers.

$D\sqrt{s} = 14.75\sqrt{68} = 121.69$
− 36.30
85.39
$.11n$ = .22
Weight 18.78

Weight of Shafting, Etc.

Crank, $D^2L = 16^2 \times 57.76 = 14786.6$
Thrust, " $= 15.75^2 \times 38.88 = 9644.6$
Line, " $= 15.75^2 \times 70.00 = 17364.2$
Prop'r, " $= 16^2 \times 78.00 = 19968.0$
61763.4
.0026
159.76

Crank $d^2L = 7.5 \times 57.76 = 3361.5$
Thrust " $= 7.5 \times 38.88 = 2187.0$
Line " $= 7.5 \times 70.00 = 3937.5$
Prop'r " $= 7.5 \times 78.00 = 4387.5$
12873.5
.0012
− 15.45
Weight 144.31

Wt. of Water in Boilers.

Double ended:—
$D^2L = 15.25^2 \times 21.25 =$ 4941.9
A $\frac{HS \times d}{12\pi} = \frac{5659.7 \times 2.25}{12 \times 3.14} = 338.7$
A $nf^2l = 8 \times 3.25^2 \times 7.66 = 786.0$
1124.7
$.0117N =$ .0468
178.64

Single ended:
$D^2L = 15.25 \times 10.96 =$ 2548.9
A $\frac{HS \times d}{12\pi} = \frac{2829.9 \times 2.25}{12 \times 3.14} = 169.35$
A $nf^2l = 4 \times 3.25^2 \times 7.6 = 389.73$
559.1
1989.8
$.0117N =$ .0234
46.56 46.56
225.20
Less weight of 2 inches = 6.57
Weight = 218.63

Boiler-Room Weights.

Double ended:—
$D^2(L+2) = 15.25^2 \times 23.25 =$ 5407.0
$HS =$ 5659.7
11066.7
.0093
102.92
$N =$ 4
411.68
$5N =$ + 20.00
Weight 4 D. E. 431.68

Single ended:—
$D^2(L+2) = 15.25^2 \times 12.96 =$ 3014.0
$HS =$ + 2829.9
5843.9
.0085
49.68
$N =$ 2
99.34
$10N =$ + 20.00
Weight 2 S. E. 119.34
" 4 D. E. 431.68
Total weight 551.02

Summary.

Engine-room	337.16
Shafting, etc	144.31
Propellers	18.78
Boilers	551.02
Water	218.63
Total weight	1269.90

weights of water tube boilers, and, as they are at present largely in the experimental stage, it was deemed desirable to postpone the discussion of their weight until a future occasion.

ADDENDA.

Since this paper was written it has occurred to the writer that in certain cases it might be desirable to estimate the weight of, boilers and

MACHINERY OF MERCANTILE SCREW STEAMERS.

Name of vessel.	Atlantic liner. 1	Brazilian coaster. 2	West India trader. 3	Coasting steamer. 4	Ocean tug. 5	Atlantic cattle steamer. 6	Coasting steamer. 7	Brazilian coaster. 8
ENGINES—								
Number of sets	1	1	1	2	2	1	1	1
Type	V. C.	V. C.	V. C.	V. C.	V. C.	V. C.	V. T.	V. T.
Number of cranks	3	2	2	2	2	2	3	3
Diam. H. P cyl. (inches)	63	35	32	30	21	48	29	27
" I. P. " "	—	—	—	—	—	—	44	40.5
" L. P. " "	(2) 91	70	63	60	42	90	70	61
Stroke (feet)	5.5	3.75	3.75	3.0	2.7	5.0	4.0	3.75
Revolutions	68	73.3	74	78.7	77.3	55.6	80	83.5
I. H. P	8500	1924	1510	2516	1105	2700	3200	2339
SHAFTING—								
Total length of crank (feet)	31.08	14.5	13.0	26	19.2	19.33	20.42	18.0
" " thrust "	82.30	60.83	70.1	83	64	68	71.16	81.31
" " line "								
" " propeller "	36.00	31.88	27.5	70	60	120.33	24	24.66
Diam. of crank (inches)	22	12¾	12	11	8½	17	14	12¾
" thrust "	20	12	11¼	10½	8	15¾	12¾	12
" line "								
" propeller "	22	12½	11¾	11	8½	17	13½	12½
Diam. of hole, crank (inches)	—	—	—	—	—	—	—	
" " thrust "	—	—	—	—	—	—	—	
" " line "	—	—	—	—	—	—	—	
" " propeller "	—	—	—	—	—	—	—	
PROPELLERS—								
Number	1	1	1	2	2	1	1	1
Diameter (feet)	22.0	14.25	14.5	12.0	11.0	20.0	15.0	14.25
Pitch "	29.0	19.00	17.25	20.0	14.0	22.5	22.75	18.00
Surface (one) (sq. ft.)	164	80	70	66	36	85	73	64
Number of blades	4	4	4	4	4	4	4	4
*ENG. ROOM WTS. (tons)	672.4	177.45	127.75	232.65	111.63	336.55	195.9	179.7
Do. ÷ I. H. P.	.079	.0923	.0846	.0925	.101	.125	.0612	.0769

* Recorded weights.

Name of vessel.	Atlantic liner. 9	Atlantic liner. 10	Brazilian coaster. 11	Channel steamer. 12	Coasting steamer. 13	Coasting steamer. 14	Great Lake steamer. 15	Campania. 16
ENGINES—								
Number of sets	2	1	1	2	1	1	1	2
Type	V. T.	V. T.	V. T.	V. T.	V. T.	V. T.	V. T.	V. T.
Number of cranks	3	3	3	3	3	3	3	3
Diam. H. P. cyl. (inches)	45	35.5	27	24	13.5	13.5	22	(2) 37
" I. P. " "	71	56	40.5	37	22	22	35	79
" L. P. " "	113	89	61	56	34	34	56	(2) 98
Stroke (feet)	5.0	4.5	3.75	2.75	2.0	2.0	3.66	575
Revolutions	91	74	85	172	106	79.5	—	—
I. H. P.	20120	4500	2230	5550	450	325	—	—
SHAFTING—								
Total length of crank (feet)	69.0	24.5	18.0				30	140
" " thrust "	170.0	138.13	87.25	112	90	75	60	246
" " line "								
" " propeller (ft.)	203.2	27.00	24.66					
Diam. of crank (inches)	20¼	17	12¾					26
" thrust "	19¼	16	12	11	6	6	12¼	24
" line "								
" propeller "	20½	18	12½					
Diam. of hole crank (inches)	3½	—	—	—	—	—	—	—
" " thrust "	—	—	—	—	—	—	—	—
" " line "	—	—	—	—	—	—	—	—
" " propeller "	—	—	—	—	—	—	—	—
PROPELLERS—								
Number	2	1	1	2	1	1	1	2
Diameter (feet)	19.5	19.0	14.25	11.0	10.0	10.75	13.16	20 ?
Pitch	28.0	21.5	18.00	13.75	8.42	11.00	16.0	—
Surface (one) (sq. ft.)	96	90	64	29	25	30	64	140 ?
Number of blades	3	4	4	3	4	4	4	3
*ENG. ROOM WTS. (tons)	1293.0	417.1	182.0	224.4	42.15	43.4	?	?
Do. ÷ I. H. P.	.0643	.0927	.0816	.0405	.0937	.134	—	—

* Recorded weights.

mountings only, separate from the other boiler formulae, under the head, "Boiler Room

MACHINERY OF MERCANTILE SCREW STEAMERS.

Name of vessel.	Atlantic liner. 1			Brazilian coaster. 2	West India trader. 3	Coasting steamer. 4	Ocean tug. 5	Atlantic cattle steamer. 6
Main Boilers—								
Type	Scotch D. E.	Scotch D. E.	Scotch S. E.	Scotch D. E.	Scotch D. E.	Scotch D. E.	Scotch S. E.	Scotch D. E.
Working pressure	95	95	95	90	90	100	100	90
Number	3	3	1	2	1	2	2	2
Diameter (feet)	14.42	14.25	14.66	12.75	14.58	13.50	12.75	18.00
Length "	17.50	17.50	11.00	15.00	17.50	16.66	10.00	17.50
Total heating surface		22749		4748	3300	5154	2270	10000
" grate "		865		189	126	240	103.5	360
One boiler. Furnaces, No. and type	6 corrugated	6 corrugated	3 corrugated	6 corrugated	6 corrugated	6 corrugated	3 plain.	8 corrugated
" diameter (feet)	3.38	3.38	3.42	3.16	3.42	3.5	3.0	3.75
Tubes, diameter (inches)	3½	3½	3½	3	3½	3¼	3½	3½
" length (feet)	7.0	7.0	7.5	5.88	7.0	6.7	6.95	7.0
" heating surface	2977.33	2910.0	1943	1872.5	2840	2159.5	917	4310
Plate, " "	479.33	467	305	501.5	460	412.5	218	690
Total " "	3456.66	3377	2248	2374.0	3300	2572	1135	5000
Height of water (inches)		8		8	—	8	8	?
Auxiliary Boilers—								
Type and number		1 Scotch.		1 vertical.	1 vertical.	1 vertical.	—	1 Scotch.
Diameter and length (feet)		10×9		4.5×9.4	6×13	4×5	—	10×9
Heating surface		710		73.5	159	190	None.	620
Grate "		40		10.5	22	13	—	—
Boiler-Room Wts. (tons)		783.94		165.11	128.25	187.5	105.9	355.90
Do. ÷ I. H. P.		.0922		.0858	.0849	.0745	.0959	.132
" ÷ heating surface		.0345		.0348	.0389	.0364	.0467	.0356
" ÷ grate "		.906		.873	1.018	.781	1.023	.989
Weights by Formulæ—								
Engines		481.48		124.83	105.53	162.00	86.50	248.02
Shafting		169.95		41.87	37.80	53.91	25.33	83.68
Propellers		16.95		10.01	9.35	13.44	6.52	16.28
Main boilers		496.99		105.56	73.82	121.20	72.46	220.51
" " water		218.60		44.37	33.72	54.35	31.18	103.30
Auxiliary boilers and water		27.90		5.88	10.51	7.98	—	27.90
Estimated total weight (tons)		1411.87		332.52	270.73	412.88	221.99	699.19
Recorded " " "		1456.34		342.56	256.00	420.55	217.53	692.45
Error per cent.		−3.0%		−2.9%	+7.3%	−1.8%	+2.0%	+1.0%

Name of vessel.	Coasting steamer. 7	Brazilian coaster. 8	Atlantic liner. 9	Atlantic liner. 10		Brazilian coaster. 11	Channel steamer. 12	Coasting steamer. 13
Main Boilers—								
Type	Scotch D. E.	Scotch D. E.	Scotch D. E.	Scotch D. E.	Scotch S. E.	Scotch D. E.	Scotch D. E.	Scotch S. E.
Working pressure	150	150	150	160	160	160	160	160
Number	2	2	9	3	1	2	2	2
Diameter (feet)	13.5	13.16	15.5	13.58	14.83	13.16	15.0	8.83
Length "	16.0	15.0	19.13	17.75	11.00	15.0	18.83	9.0
Total heating surface	6648	5204	50040	13174		5204	12110	1280
" grate "	208	180	1293	408		180	300	?
One boiler. Furnace, No. and type	6 corrugated	6 corrugated	6 corrugated	6 corrugated	3 corrugated	6 corrugated	8 corrugated	2 Brown.
" diameter (feet)	3.16	3.16	3.83	3.2	3.2	3.16	3.0	2.33
Tubes, diameter (inches)	2½	2½	2½	2½	2½	2½	2½	—
" length (feet)	6.25	5.88	7.5	7.15	7.15	5.88	7.25	—
" heating surface	2880	2215	4990	3066.6	2279	2215	—	—
Plate, " "	444	387	570	456	327	387	—	—
Total " "	3324	2602	5560	3522.6	2606	2602	6055	640
Height of water	8	8	8	8	8	8	8	—
Auxiliary Boilers—								
Type and number	1 Scotch.	1 Scotch.	2 Scotch.	2 Scotch.		1 Scotch.	1 Scotch.	None.
Diameter and length	7×7	6.3×7.3	8.7×9.5	10×9		6.3×7.3	7×7.5	
Heating surface	236	230	522	695		230	230	
Boiler-Room Wts. (tons)	204.7	187.0	1457	480.5		187	307	51.66
Do. ÷ I. H. P.	.0758	.0800	.0674	.107		.0838	.0553	.115
" ÷ heating surface	.0308	.0359	.0271	.0365		.0359	.0253	.0404
" ÷ grate "	.984	1.039	1.05	1.178		1.039	1.02	?
Weights by Formulæ—								
Engines	158.90	124.22	861.80	261.70		124.22	166.53	30.54
Shafting	51.85	48.06	458.34	133.09		50.31	70.47	8.42
Propellers	10.09	8.54	40.18	15.83		8.54	5.04	1.50
Main boilers	132.85	113.02	935.24	271.45		113.02	209.81	45.22
" " water	54.38	48.50	375.50	114.62		48.50	77.55	15.10
Aux. boilers and water	10.63	9.01	44.23	55.80		9.01	13.08	—
Estimated total weights (tons)	418.70	351.35	2715.29	852.49		353.60	542.48	100.78
Recorded " " "	400.60	366.70	2650.00	897.60		369.00	531.40	93.81
Error, per cent.	+4.5%	−4.2%	+2.4%	−5.0%		−4.2%	+2.1%	+7.4%

room weights which are included in the general Weights" (page 20 February issue). For this

purpose the formulae on page 20 will approximate closely to the desired weight.

The weight obtained by this formulæ includes, weight of boilers complete; tubes ordinary and stay grates, bearing bars, bridges, furnace fronts and doors, firebricks and other fittings, stop, safety, check, blow and other valves, internal piping, hydrokineters, circulating plates, lagging including angle iron, etc., for securing them.

MACHINERY OF MERCANTILE SCREW STEAMERS.

Name of vessel.	Coasting steamer. 14	Great lake steamer. 15	Campania. 16	
MAIN BOILERS—				
Type	Scotch S. E.	Scotch S. E.	Scotch D. E.	Scotch S. E.
Working pressure	160	170	160	160
Number	1	2	12	1
Diameter (feet)	10.0	13.5	18.0	18.0
Length "	10.0	12.2	17.0	11.0
Total heating surface	937	4130	75000 ?	
" grate "	30	?		
One boiler. Furnaces, No. and type	2 Brown.	2 corrugated	4	4
" diameter (feet).	2.75	4.0	—	—
Tubes, diameter (inches)	2¾	2½	3	3
" length (feet)	—	8.25	—	—
" heating surface	—	—	—	—
Plate, " "	—	—	—	—
Total " "	937	2065	—	—
Height of water	8	—	—	—
AUXILIARY BOILERS—				
Type and number	1 vertical.	1 vertical.	1 Scotch.	
Diameter and length (feet)	3.5×7.5	4×8.8	10×10	
Heating surface	—	—	—	
Grate "	—	—	—	
BOILER-ROOM WTS. (tons)	42.20	?	?	
Do. ÷ I. H. P.	.130			
" ÷ heating surface	.045			
" ÷ grate "	1.407			
WEIGHTS BY FORMULÆ—				
Engines	30.54	101.12	907.92	
Shafting	7.49	24.38	614.47	
Propellers	1.77	7.83	44.26	
Main boilers	28.16	95.70	1487.91	
" " water	11.85	43.96	659.00	
Aux. boilers and water	5.15	4.30	31.00	
Estimated total weights (tons)	84.96	277.29	3744.56	
Recorded " " "	81.10	260.80	?	
Error, per cent	+4.7%	+2.5%	?	

[From a paper read before the Society of Naval Architects and Marine Engineers, at the fifth general meeting. The preceding chapter appeared in our February issue. An interesting query and reply concerning this paper will be found on page 37 of this issue.—ED.]

Loss of the British Ship Blairmore.

Lying on the mud banks of the estuary at Oakland, Cal., is the hulk of the British ship Blairmore. Captain John Caw, who brought the vessel out here from England about two years ago, is anxiously awaiting the decision of the highest court of the United Kingdom in the matter of the Blairmore Ship Company vs. the English Insurance Companies. The story of the Blairmore is one of the strangest in the annals of Pacific coast marine disasters. Though much has been said concerning the ship's crew and the awful death of seven of their number during the storm in the bay of San Francisco on April 9, 1896, little has been recorded concerning the later developments in the case; successful attempts to raise her and the litigation that has followed these attempts.

From all appearances the "Blairmore" is a complete wreck. She lies low in the mud, with two stumps of masts, main and mizzen, showing above her bulwarks. Her deck houses are intact, but her decks are strewn with wreckage of rigging and spars. A temporarily patched up plate is hidden by the mud of the starboard side amidships, and about four feet from the keel; otherwise the hull is in a good state of preservation, though to the eye of the inexperienced it seems to be a worthless mass of rusty iron.

On the morning of April 9, 1896, news was received at the Merchants' Exchange, San Francisco, that a British ship had been "tripped" by her anchor in the south wing of the bay and capsized. This was about 7.30 o'clock. Fifteen minutes later the writer, on the tug Millie, left the Clay street dock for the scene of the disaster, which was at a point opposite the Union Iron Works Ship Yard at South San Francisco. The weather was squally and a light rain was falling. Quite a sea was running, but judging from the nature of the storm it did not seem possible that an accident of a serious nature could have been caused by the blow. The tide was at the flood. Not a sign of the Blairmore was visible above the waves.

The Millie steamed alongside of the iron works dock and there it was learned that the Britisher had capsized during a squall of unusual severity, that all but seven members of her crew had been picked up by boats from ships anchored near by and that Captain Caw had hurried to the British Consulate for assistance. The first officer and six seamen had been working in the hold when the ship capsized, and were drowned, as was learned later.

Very little could be done except cruise about the spot where the ship had been anchored and take soundings. Five, and five and two-thirds fathoms of water were logged. The starboard bilge of the ship was located about 3 ft. below the surface for a distance of 50 ft. or more. The tide had turned and was rapidly out. At 9.30 o'clock the hull showed 2 ft. above the water and appeared to have some buoyancy. The weight of the masts probably held it down.

A peculiar sound came from within the hull. It was subsequently found that the noise was caused by a rush of air within, but it was first mistaken for the voices of those imprisoned within the steel tomb. Word was sent to the Union Iron Works and a number of mechanics in charge of Superintendent Dickie rowed to the

wreck in a small boat. Four men, with sledges and chisels, cut a hole 2 ft. dia. in the plate. The opening of the hull was followed by a great rush of air, and the hull settled in the mud a couple of feet.

The Blairmore was insured for $50,000, but the owners, instead of turning the wreck over to the Marine Underwriters, undertook to raise her themselves. Captain Burns, an expert wrecker, was sent to San Francisco from England, and on arrival he secured the services of the wrecking steamer T. P. H. Whitelaw, the only craft in the harbor mechanically fitted to undertake so difficult a task.

The Whitelaw's divers first removed the upper spars and yards of the wreck. Water tanks were then rigged out on platforms attached to the starboard topsides of the ship at such an angle as to place the center of gravity of the tanks at a point beyond the turn of the bilge. Then the powerful pumps of the tugboat Fearless were started and the tanks filled. The "Whitelaw" attached chain gear to the stumps of the fore and mizzen masts, slung out its great derricks and lifted on the spars. Prior to this work the hole in the bilge was temporarily closed with a lap plate.

On June 23, 1896, the Blairmore was righted and towed to the flats at Oakland. On July 18 she was towed back to the Union Iron Works, but as litigation between owners and insurance companies had by this time commenced, the ship was towed back to the flats, where she has remained until this day.

The owners had spent $35,000 to raise the ship. They attempted to recover the full $50,000 from the underwriters. The insurance men alleged that the hull should have been turned over to them immediately after disaster. They have won their case in two courts in England, and the matter is now on appeal before the highest tribunal of the Old Country.

On April 16, 17, and 18 the naval court of inquiry in the Blairmore case was held in San Francisco, before British Vice-Consul Wellesley Moore, acting for Consul Warburton, absent in England. Captain Caw testified that the Blairmore was a Glasgow built ship of 1,767 tons register, and that she had on board at the time of the accident 270 short tons of ballast. Lengthy testimony was introduced to prove that the disaster was not the fault of the officers of the ship, but was caused by a peculiar combination of circumstances made plain in the finding of the court which held that the master of the "Blairmore" had not been negligent in providing, as he believed, sufficient ballast for the ship, the stability of which had never been called in question. That the crew was at work in the hold at the time of the mishap was an unfortunate circumstance. The ship was capsized by a heavy squall while riding ahead of her anchor, forcing the ship across the cable, which tightened with the strain, causing her to swing across the tide.

REPORT OF THE "MAINE" NAVAL COURT OF INQUIRY

A SUBMARINE MINE CAUSED THE PRIMARY EXPLOSION.

Finding of the Court Containing this Conclusion—Lengthy Extracts from the Testimony in the Original Text—Reproduction of Many Official Views and Drawings of the Wreck.

(Second Installment.)

In continuation of the evidence of Lieutenant George F. M. Holman, U. S. N.

Q. How much powder was stowed in the forward 10-inch magazine?

A. I think there were about 150 or 160 tanks, representing seventy-five or eighty charges, say, approximately, some of these being full and others reduced charges, some 125 pounds to the tank, that being the weight of one of the tanks of a full charge. These figures I give I cannot be exact in.

Q. I suppose there were about as many shell in the shell rooms as there were full charges in the magazine?

A. Yes, probably the same number.

Q. How was the fixed-ammunition room forward located?

A. Over near the midship line of the vessel, abaft the 6-inch magazine.

Q. Can you state approximately what that contained at the time of the explosion?

A. That contained 6-pounder and 1-pounder shell and small-arm—that is, rifle and 6-millimeter—ammunition. I cannot say how much.

Q. What was in the forward 6-inch magazine?

A. About two hundred or more 6-inch charges and a corresponding number of shell in the shell room adjoining.

Q. On which side was the powder stowed?

A. A little over to the port side of the midship line.

Q. In the 10-inch magazine forward the powder was to starboard of the shell, was it not?

A. Yes.

Q. You have stated that you were also the electric officer of the ship. Will you please state what wiring went down into the magazines and shell rooms? I mean the forward one.

A. None. There were electric lamps in the light boxes, and wires leading to these lamps, but they were separated from the magazine by a double plating of glass.

Q. Were there any steam pipes in dangerous proximity to the magazine or shell room?

A. No.

Q. Were you on board at the time of the explosion?

A. Yes.

Q. Did you notice any serious action of the electric light which would indicate grounding just previous to the explosion?

A. No.

Lieutenant Commander Richard Wainwright, executive officer of the "Maine," in the course of his examination, was asked:

Q. What was the discipline on the part of the officers and men immediately following the explosion?

A. I consider it excellent. All orders were obeyed with the promptness of a drill. The captain told me what orders he wished me to give, and the only order not promptly obeyed was the final order to leave the ship, and the officers hesitated until it was given in an imperative manner.

Q. Will you please describe the wreck as you found it after you had a full chance to examine it by daylight?

A. The after part of the ship appeared to be intact from the crane aft, with a heavy list to port, the port turret being about 2 feet under water. The main deck was folded back, carrying the central superstructure with it at a line between the two cranes and about the line between the two fire rooms. It was folded in a direction from port to starboard, so that the port 6-inch gun was lying nearly over the starboard 6-inch gun, the conning tower pointing downward about where the armory was—that is, the starboard after corner of the superstructure. The forward smokestack was lying abreast and partly over where the first whaleboat hung; the siren was on the starboard side of the after superstructure. The after smokestack was lying on the port side abreast of the fore-and-aft bridge, between the after and central superstructure. At the lowest tide we had I stood on the port waterways, and could see nothing that I could recognize as any part of the ship forward of the crane on the port side of the main deck.

There were some portions of the wreck forward of this line mentioned on the starboard side. By looking in underneath it I saw a torpedo port, apparently of the starboard forward torpedo. I recognized part of the washroom—I believe it was part of the foremen's washroom—immediately abaft the starboard turret having a small scupper with a lip, a holddown valve, and also a half round bulkhead separating portions of the washroom. Forward of that again I recognized pieces of bottom plating with anchor scars. They had a triangular piece that led me to believe it to have been under the starboard anchor. Forward of that was some wreckage with old rope, which I think had been where the anchor gear was stowed. Forward of that one of the fore yardarms was sticking up. As far as I can tell from the above water view, there is an angle between the after body of the ship and the forward, with an apex to starboard.

Chief Engineer Charles P. Howell, of the "Maine," gave testimony regarding the location of the bunkers in the vessel, and was asked:

Q. What coal bunkers on board the *Maine* are adjacent to the magazines in the forward half of the ship; I mean magazines and shell rooms?

A. If I could refer to the blue print I could tell you the numbers of them. A15 is on the forward starboard side under the forward turret. That is adjacent to the 10-inch magazine. A16 is similarly situated on the port side, and that is adjacent to the 6-inch reserve magazine, I think they call it. B3 is on the starboard side, and B5 is also on the starboard side. They are adjacent to the magazine. B4 and B6 are on the port side, also adjacent to the 6-inch reserve magazine.

Q. The first two are adjacent to the 10-inch magazine?

A. Yes, sir. Perhaps I could state that a little better now, as I first went from the starboard side to the port side and back again.

Q. Go ahead in your own way. Make it as plain as you can.

A. On the starboard side, adjacent to the 10-inch magazine, are coal bunkers A15, B3, and B5. On the port side, adjacent to the 6-inch reserve magazine, are coal bunkers A16, B4, and B6.

Q. Please state to the court, as near as you can recollect, the history of coal bunker A15, from the time you joined the ship up to the time of the explosion?

A. A15 is a bunker which it is difficult to put coal in or to take coal out of, and, besides, you have to go through B4 and B5. To take coal out of A15 you first have to empty B3 and B5, and to put coal in A15 you have to partially fill B5, and then fill from B5 into A15. As I say, it is a difficult bunker to put coal in and take coal out. Those bunkers forward have been emptied as frequently as possible in order to lighten the ship forward. We have always tried to take coal out of the forward bunkers as much as possible, because when they are full the ship has a tendency to go down forward. It was the same way on the port side. A16 is a difficult bunker to fill, and is the last one that is emptied on the port side, because we have to take coal out of B4 and B6 before we can take any out of A16.

Q. Have you always inspected coal on board the *Maine* before receiving it?

A. Yes, sir.

Q. Have you, during the time you have been chief engineer of the *Maine*, had any signs of any kind of spontaneous combustion in the coal bunkers?

A. No, sir; none whatever. In connection with that I have frequently examined the different bunkers all around everywhere, and the different kinds of coal. I have never seen any signs whatever of any bunker heating. I have examined them from the outside, and when they have taken coal out of them; also particularly when we have taken in coal that I thought was more liable to spontaneous combustion than other coal. I have never seen any signs of heating.

Q. When did you make your last examination of these bunkers, previous to the explosion?

A. Bunkers B3, B5, B4, and B6—unless you want to consider some others, I will not mention any others—are emptied, and they have been emptied about two weeks.

Q. That is, previous to the explosion?

A. Yes, sir; B3, B5, B4, and B6.

Q. Those have been empty?

A. They have been empty ten days or two weeks. All of those have been entirely empty. In that time we have painted all those bunkers and we have scaled them. Also we have scaled the chutes that led down to them, and painted them. A15 was about half empty until the day of this explosion. On that day, at 4 o'clock, we began taking coal from A15, to keep the ship on an even trim. I have not been in that bunker personally since they began taking coal out of it, though I have passed around these bunkers, and I felt of them within a week on both sides. I have been to the wing passages, and every time I go through there I can feel those bunkers. I pass right by the bunkers. It is a quarter of an inch thick, and I put my hand on them. I never have gone through there without putting my hand on them to feel the temperature.

Q. You never found any signs of heating?

A. I never found any signs of heating—any variation.

Q. Regarding the steam piping of the *Maine*, was there any piping in dangerous proximity to the forward magazines or shell rooms?

A. No, sir.

Q. Did any steam pipes lead through bunker A16?

A. No, sir.

Q. What boilers were in use at the time of the explosion?

A. The two aftermost boilers in the ship, one on each side.

Q. What was the condition of those boilers?

A. In good condition. We were in the habit of carrying about 80 to 100 pounds of steam in port.

Q. For auxiliary purposes?

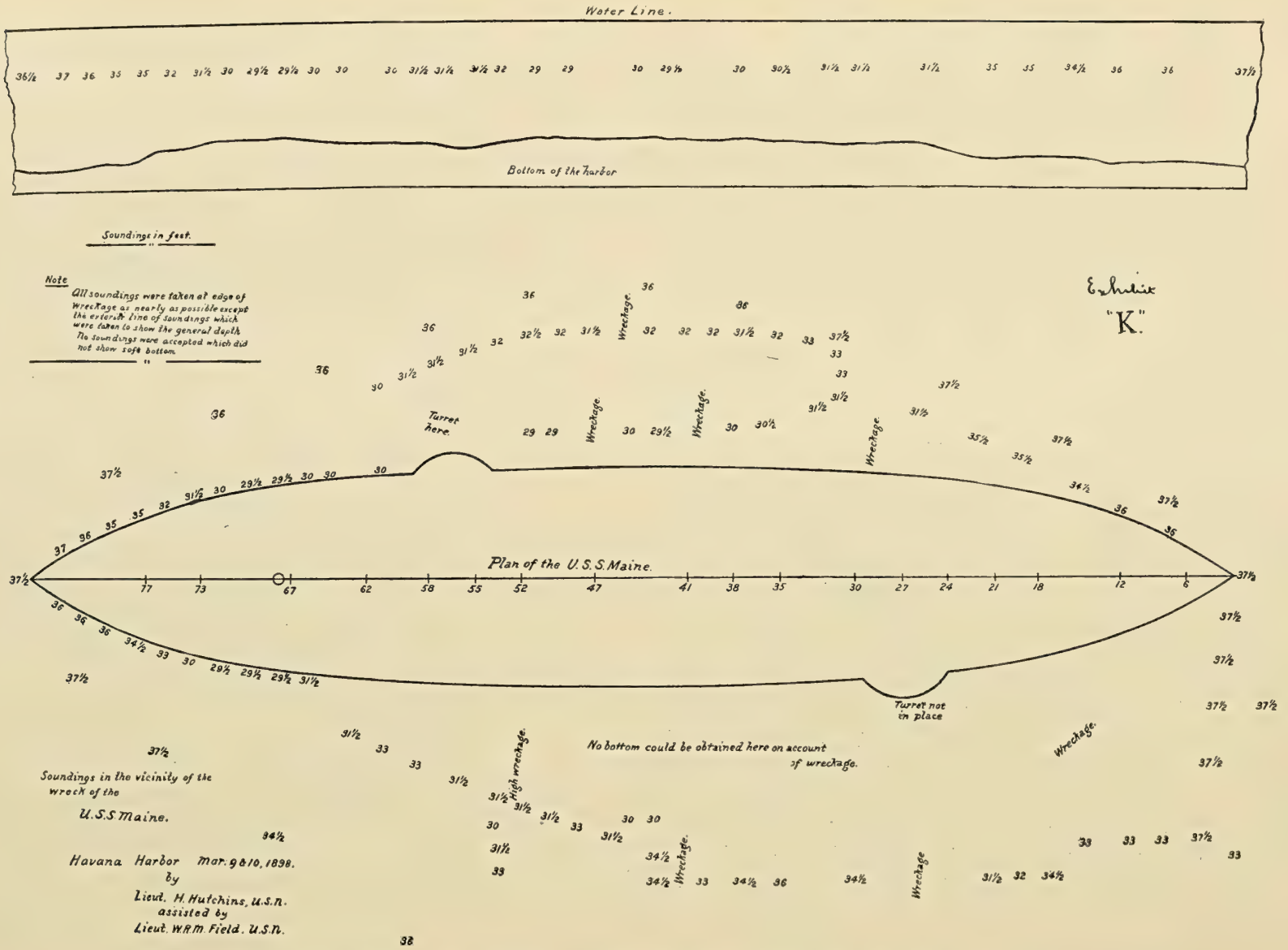
A. For auxiliary purposes, in port.

Q. How much did you carry in those same boilers when steaming at sea?

A. One hundred and twenty pounds.

Q. In your opinion it would have been impossible for those two boilers to explode with the pressure they were carrying?

A. Yes, sir; the explosion would not have done much damage under ordinary circumstances.


Water Line.
Bottom of the harbor
Soundings in feet.
Note
All soundings were taken at edge of Wreckage as nearly as possible except the extreme line of soundings which were taken to show the general depth. No soundings were accepted which did not show soft bottom.
Exhibit "K."
Turret here.
Wreckage.
Plan of the U.S.S. Maine.
Turret not in place
No bottom could be obtained here on account of wreckage.
high wreckage
Soundings in the vicinity of the wreck of the U.S.S. Maine.
Havana Harbor Mar. 9 & 10, 1898.
by
Lieut. H. Hutchins, U.S.N.
assisted by
Lieut. W.R.M. Field. U.S.N.

SURVEY OF SOUNDINGS AROUND THE WRECK OF THE "MAINE," MADE FOR THE NAVAL COURT OF INQUIRY.

Paymaster Charles M. Ray, of the U. S. S. Maine, testified:

Q. Referring to your storerooms in the forward part of the *Maine*, was there any inflammable or dangerous matter stowed in any of those storerooms?

A. Not to my knowledge and belief, sir.

Q. What was stowed forward belonging to your department, and where was it stowed?

A. I think thehe are the only two rooms I had [indicating on blue print]. There was stored in them preserved meats, small stores, and some clothing.

Ensign W. V. N. Powelson, who was serving on the "Fern," which was sent to Havana immediately following the explosion, and who had charge of the divers, said in response to an inquiry:

A. The divers do not seem to be able to express themselves as to what they see down below. I have talked to them and have not been able to learn very much.

Q. That is the difficulty; they do not know what they find.

A. They see things there, but they do not know exactly what they are or what the conditions are.

Chief Engineer Howell, recalled, was asked:

Q. What instructions did you have from your commanding officer in regard to old cotton waste that had been used?

A. We have a number of copper tanks in the engine room and fire room, about 22 inches high and 15 inches in diameter, with covers on them. They are kept there for the purpose of putting old refuse in them, and oil waste and anything of that style that has been used. Every day they are carried away, thrown in the ash pile and thrown overboard.

Captain Frederick G. Teasdale, master of the British bark Dera, which was lying in Havana harbor, was asked where he had been at the time of the explosion, and he replied:

A. Sitting at the cabin table writing when I heard the explosion. I thought the ship had been collided with. I ran on deck when I heard the explosion. I felt a very severe shock in my head also. I seized my head this way [indicating]. I thought I was shot, or something. The transoms of the doors of the cabin are fitted in the studs on the side, and they were knocked out of place with the shock. The first seemed to be a shot, and then a second, or probably two seconds, after the first report that I heard, I heard a tremendous explosion; but as soon as I heard the first report—it was a very small one—thinking something had happened to the ship, I rushed on deck, and was on deck just in time to see the whole débris going up in the air.

Q. Please describe, as graphically as you can, how this appeared to you—what you saw.

A. The stuff ascended, I should say, 150 or 160 feet up in the air. It seemed to go comparatively straight until it reached its highest point of ascent. Then it divided and passed off in kinds of rolls or clouds. Then I saw a series of lights flying from it again. Some of them were lights—incandescent lights. Sometimes they appeared to be brighter, and sometimes they appeared to be dim, as they passed through the smoke, I should presume. The color of the smoke, I should say, was very dark slate color. There were fifteen to twenty of those lights that looked like incandescent lights. The smoke did not seem to be black, as you would imagine from an explosion like that. It seemed to be more a slate color.

Q. Was there anything that appeared to you to be shooting stars or anything like that?

A. No; I never saw anything like that; only a series of smaller explosions, after the first one, you know. That occurred at stated intervals, probably twenty minutes or half an hour each. You would hear small reports from the deck, as if they were scattered shells about the deck which were going off, but they would not do any harm; some going in one direction and some in another.

Q. Did you see any dead fish around the bay?

A. I never saw any; no, sir.

Q. Have you ever heard that fish leave this harbor at night and go outside?

A. I never heard any remark about that. I have seen a good many fish here, but they were very small fish, just spluttering about on the top of the water. I have never seen any in the night time, but any time when there is any spluttering among the fish it generally occurs in the daytime, so far as my observation has gone. The wind coming in that direction carried a lot of light material over our vessel that night. Quantities of paper and small fragments fell over our ship, and for some time after. I picked up some boiler coating or coating for steam pipes the next morning. There also seemed to be felt and hair.

Sigmond Rothschild, of Detroit, a passenger on the Ward liner City of Washington, who was an eye-witness of the disaster, described his impressions:

Q. How far was the *City of Washington* from the *Maine* at the time of the explosion?

A. I cannot give the exact distance, but I asked Captain Stevens, captain of the *Washington*, what distance he would call it, and he said about 300 feet.

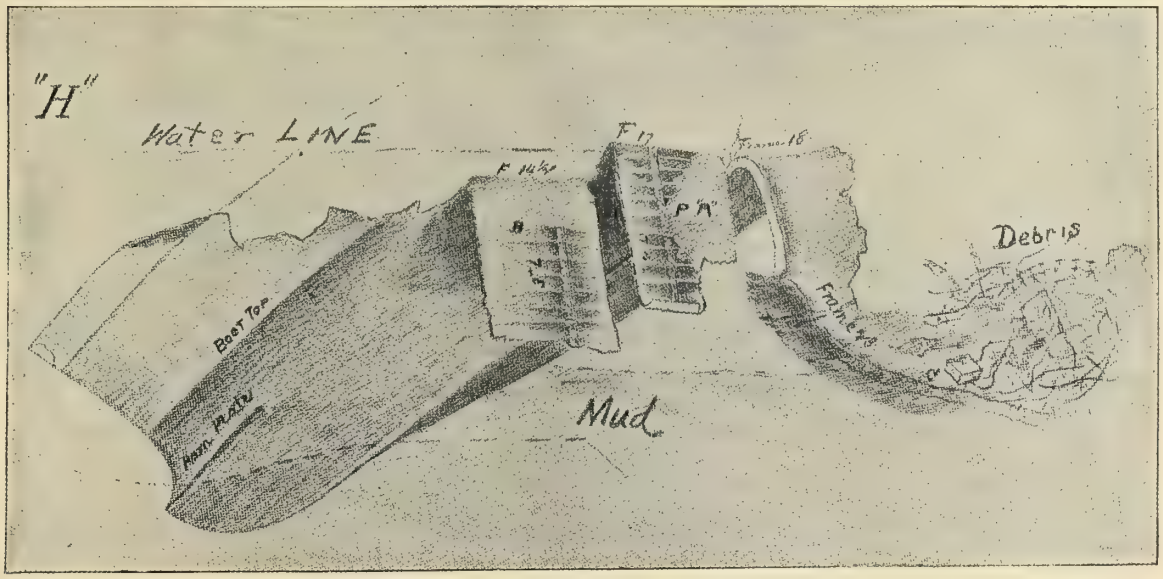
Q. Where were you at the time it happened?

A. Right on the stern of the boat. I had brought my chair just about in this condition [indicating], and had not sat down when I heard a shot, the noise of a shot. I looked around and saw the bow of the *Maine* rise a little, go a little out of the water. It couldn't have been more than a few seconds after that noise, that shot, that there came in the center of the ship a terrible mass of fire and explosion, and everything went over our heads, a black mass. We could not tell what it was. It was all black. Then we heard a noise of falling material on the place where we had been, right near the smoking room.

One of the lifeboats which was hanging had a piece go through it and make a big hole in it. After we seen that mast go up, the whole boat lifted out, I should judge, about 2 feet. As she lifted out, the bow went right down. It didn't take a minute after the lifting of the boat until the bow went down. We stood spellbound, and cried to the captain. The captain gave orders to lower the boats, and two of the boats which were partly lowered were found broken through with big holes. Some iron pieces had fallen through them. Naturally, that made a delay, and they had to run for the other boats, or else we would have been a few minutes sooner in the water. Then the stern stood out like this, in this direction [indicating], and there was a cry from the people "Help," and "Lord God help us," and "Help! Help!" The noise of the cry from the mass of human voices in the boat did not last but a minute or two. When the ship was going down, there was the cry of a mass of people, but that was a murmur. That was not so loud as the single voices which were in the water. That did not last but a minute, and by that time we saw somebody on the deck in the stern of the ship, and it took about a few minutes when the boats commenced to bring in the officers. We took them to our rooms. A great many of them came without anything on but a pair of pants and nothing else. That is about the whole story in regard to the shot.

Chief Gunner's Mate Andrew Olsen of the U. S. S. Iowa, who had been at work on the wreck of the "Maine," diving, was asked:

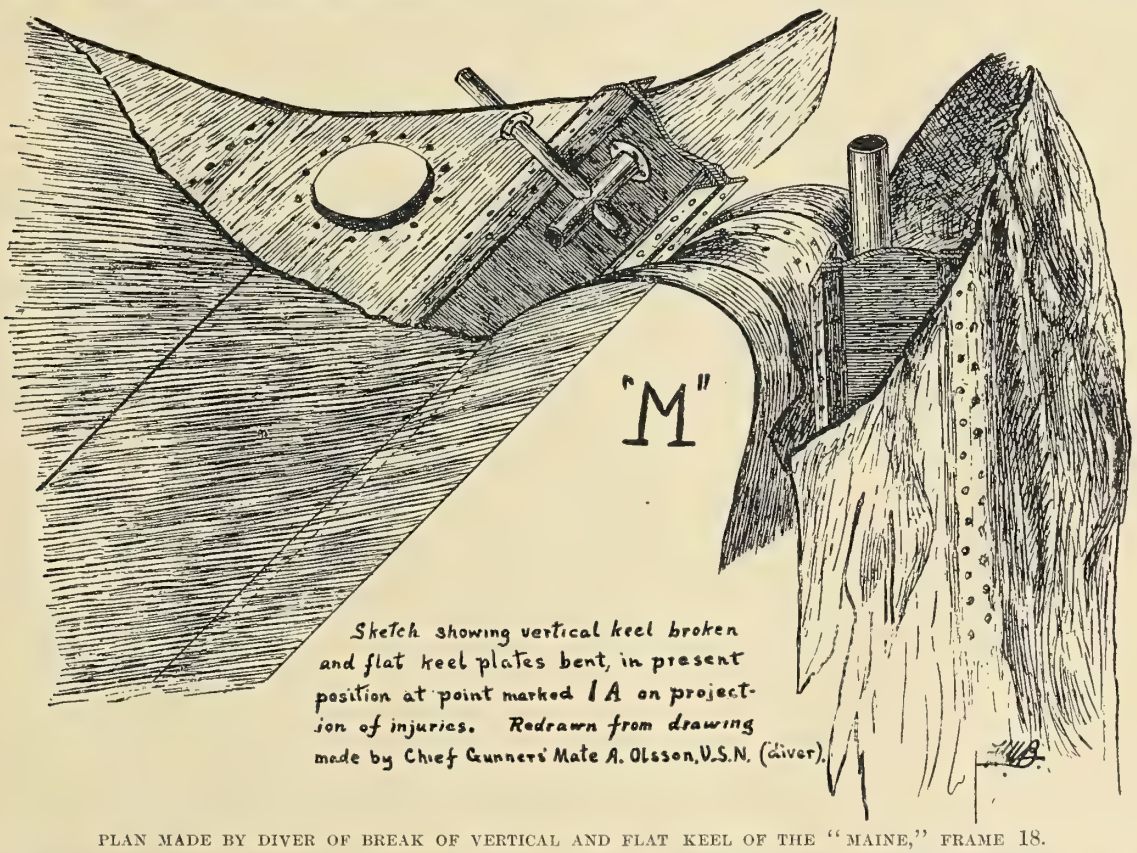
Q. Were you using any electric lights in diving?
A. Yes, sir; but the electric light was not much use to me. It merely showed a red glare, and I came to the conclusion that I was better without the light.



FORWARD PART OF THE "MAINE" UNDER WATER, KEEL ABOUT AS FAR AFT AS FRAME 28.

Gunner's Mate Thomas Smith, of the "Iowa," who had done similar work, was asked:

a rather sensational incident in the attendance of a Cuban witness whose name and address were suppressed by agreement. The chief portions of the story he related to the court are as follows:


"M"
Sketch showing vertical keel broken and flat keel plates bent, in present position at point marked 1 A on projection of injuries. Redrawn from drawing made by Chief Gunners' Mate A. Olsson, U.S.N. (diver).

PLAN MADE BY DIVER OF BREAK OF VERTICAL AND FLAT KEEL OF THE "MAINE," FRAME 18.

Q. Can you see well?
A. I can see well, when the water is anyway clear, but this water is not clear. We can't see any more than about a foot or eighteen inches out from you.

On the fifth day of the investigation there was

Q. I have heard that on Tuesday morning you overheard a certain conversation in a ferryboat which referred to the possible sinking of the *Maine*. Will you please state to the court all you can in regard to that matter?

The INTERPRETER. At about half-past 7 on the morning of the 15th, he was crossing from Havana to Reglas. He was sitting on a front seat in the bow of the vessel—the ferryboat. There were, about 4 feet distant, three officers, two of the army and one of the navy, of Spain, and besides a citizen, a stout man, about fifty years of age. They were conversing about the *Maine*. He says one of the army officers said that in the circulio militario, the military club here on the Prado, "That is nearly arranged." The citizen inquired: "Will not making explosions in the bay run great risk to the city of Havana?" The citizen inquired that from the Spanish officer who had made the first remark. He says that the officer replied "no;" that it was arranged so that it would simply explode, open the vessel, and she would sink immediately. Then the other man, with an exclamation apparently of joy, said: "I will take plenty of beer on that occasion." At that moment a cartman came forward and one of the men touched the other and stopped the conversation, and then he could not hear any more. He said they kept on speaking, but he did not hear any more.

Q. What was the first remark made by the army officer?

The INTERPRETER. That he had heard in the circulio militario that the plans were all arranged, and they were going to blow her up anyhow; that it was a shame to Spain that she should be here in the bay. The lieutenant said: "Then if you blow her up, there would be another one come," and the superior officer said: "They would take care not to send another."

Q. Did the second army officer make any other remark?

The INTERPRETER. He says yes; they were all speaking, but they were speaking in a low voice; he could not catch all they said. He was standing up, close to the wall, so that they would not notice he was listening to them.

Q. Could you distinguish what the navy officer said?

The INTERPRETER. No; he could not.

Q. What was the character of the uniform of the army officers?

The INTERPRETER. One was a lieutenant, and the other one had stars down below the stripes. He had two stripes, which would indicate that he was from a major upward. He also had a belt—that would indicate that he is of the general's staff.

As bearing on the credibility of the witness, the following replies are of interest:

Q. Are you a married man?

The INTERPRETER. No, sir; single.

Q. Have you any family here?

The INTERPRETER. He says he and his father are here, and he has been living eighteen years with a woman, but he is not married to her.

On the sixth day a translation of the anonymous letter received at the United States Consulate in Havana was read to the court thus:

It should be remembered that at dawn of the day of the terrible catastrophe an individual was killed in a small boat, together with another, who is to be found wounded and a prisoner. They were going about the cruisers *Maine* and *Alfonso XII*, and as the said individuals are the worst antecedents as harbor thieves, I have interested myself in investigating what connection this occurrence could have with the explosion of the *Maine*, and I have discovered that those two men, together with another, who is called Pepe Taco, had bought in a harware store in Mercaderes street, called La Marina, a hose such as is used by divers, and that the three left Regla in a small boat, which they placed under the wharves of Sta. Catalina, and they were loitering more than an hour and a half, while Pepe Taco, who is a calker and diver, probably the best in these parts, did the work to bring about the explosion of the *Maine*. With this data I went to Regla and discovered that the family of the dead man, who lived in the utmost misery in a house in Rodriguez Batista street, had moved to a well-furnished one in Gelabert street. There I learned that they had agreed with some merchants of Muralla street for the work of blowing up the ship for the sum of $6,000—$2,000 in advance, the other $4,000 after seeing the result. But as they did not come out of the adventure very well, having been attacked when they were retiring, the result of which was the death of one, who left his teeth in the boat, and another one wounded, the third one has not presented himself to collect the rest of the money, and it could probably be secretly done that, by paying him the rest that the others will not now pay him, he would declare the truth of all this. The one whom I call the third is the diver Pepe Taco, who was unwounded, who no doubt is afraid to present himself to collect the rest. In Muralla street they tell me was the place where the business was arranged with Messrs. Garcia Corujedo, Villasuso, Maribona, and others, whom I do not remember. The man arrested is being administered morphine constantly to see if he will die and not give evidence, so as not, as they express it, to spoil the affair after it has come off so much to their taste.

HAVANA, Feb. 11, 1898.

When the letter was read the court made inquiry as to whether any effort had been made to ascertain the truth of the information contained in the letter. A clerk in the Consulate said that General Lee had informed him there was no secret service money available for such an investigation.

Captain Sigsbee, recalled, was questioned:

Q. You are quite certain that no torpedo warhead was fitted to a torpedo on board the *Maine* the day of the explosion?

A. I am certain I gave no order to fit them, and it was well known to the executive officer that I did not intend to fit them.

Q. Did you enter the harbor of Havana with a torpedo warhead fixed?

A. No.

Q. Did you, at any time subsequent to your entry of the harbor, have the warheads on any of the torpedoes?

A. The warheads have not been disturbed in any respect since I have had command of the ship.

Lieutenant Commander Richard Wainwright, recalled, gave corroborative evidence:

Q. Were you on board the whole day on the evening of which the explosion occurred?

A. Yes, sir.

Q. Are you certain that no warheads were fitted to the torpedoes of the *Maine* on that day.

A. I am positive of it. It could not have been done without my seeing it. I knew what work was going on on the torpedoes, always. I took a special interest in them and consulted frequently with the officer in charge of the division. The Captain has ordered us not to put the warheads on. I mentioned the subject of the warheads to the commanding officer at least twice, and both times he told me not to do so.

Q. As you were on board the *Maine* during her last stay in Havana, and were frequently on deck, did it ever occur to you that the ship was almost always swinging in any certain direction?

A. A large portion of the time the wind was to the eastward, and we always swung to the wind, generally a little to the southward of east, as I remember now, though I am not positive about the points of the compass. We generally pointed to the eastern shore.

HIGH PRESSURES AT SEA WITH SOME CONSIDERATION OF TYPES OF BOILERS.*—III.

BY W. R. CUMMINS.

Fourth—Sufficient time should be given to allow the gases to give up the desired amount of their heat before they pass away to the uptake.

Fifth—There should be a sufficiently large body of water over the highest heating surface to allow the boiler to run some time with the feed shut off.

Sixth—Every part of the boiler, both inside and out, should be accessible for examination, cleaning, and repairs, and every part exposed to the heat of the furnace, or hot gases should be renewable without interfering with the main structure of the boiler, also all tubes should be straight, of fairly large diameter, and of the same length.

Seventh—The lower part of the boiler should be so arranged that if any mud or grease collects there it can do no harm by causing overheating.

Eighth—The circulation of water should be active and natural.

Finally—The cost of construction and the space occupied should not be more, and if possible should be less, than the present return-tube boiler.

As regards the first point, viz., the thickness of the material forming the heating surface, this is a most important point, as the increased temperature of the water will decrease the efficiency of the heating surface, and if, in addition, the plates have to be made thicker for the increased pressure, we shall still further decrease the efficiency. For instance, the thickness of circular furnaces would be increased for the higher pressure, unless the diameter were decreased. The thickness of the plates forming flat stayed surfaces would also need to be increased, the alternative being to decrease the pitch of the stays. The thickness of plain tubes would not need to be increased to any appreciable extent, but stay tubes would need to be thicker or closer pitched. Hence, to satisfy this first condition, preference should be given to a boiler in which the greater part of the heating surface consists of plain tubes.

As regards the second point, viz., the size and disposition of the combustion chamber, this has a well-known bearing on fuel economy. It is of the utmost importance to have a large combustion chamber, where the furnace gases may combine before they part with their heat, and where unconsumed gases may have room to pick up more oxygen or more heat, as, if their temperature is not raised to the combining temperature, they will pass away to the funnel unburnt, entailing a serious loss of heat. The ideal combustion chamber would be a large free space directly over the furnace.

As regards the third and fourth points, viz., the distribution of the gases over the heating surfaces and the time they remain in contact with the latter, this affects the efficiency of the heating surface to a large extent. To effect a given coal economy the heating surface must abstract a given amount of heat from the gases. To do this we must not only have the right extent of surface, but we must also have it so disposed as

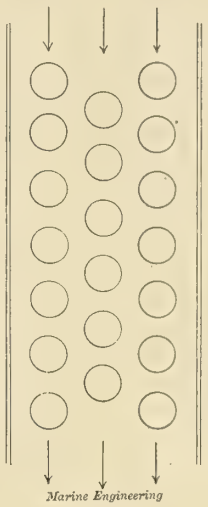


Fig. 3

to split up the gases and allow them time to give up their heat. Of course the efficiency of the heating surface will also depend upon the circulation on the water side, but that point will be touched on later. The accompanying sketch illustrates the point as to the time the gases take to travel over the heating surface. Fig. 2 represents an arrangement of 2 1-2 in. water tubes, say 2 ft. long, with the hot gases passing in the direction of the arrows. Fig. 3 shows the same tubes arranged so that the gases pass in the other direction. The area for the passage of the gases is the same in both cases; hence the velocity of the latter will be the same; but with the tubes arranged as in Fig. 3 the gases will take more than twice the

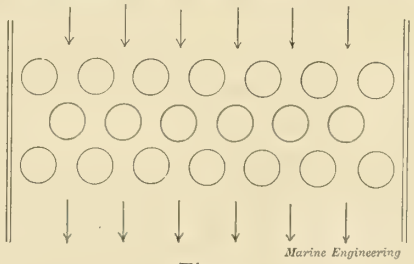


Fig. 2

time to traverse the heating surface than when arranged as in Fig. 2. Now, it might be that the time occupied in Fig. 2 would not be sufficient to extract the desired quantity of heat from the gases, and this would place the arrangement at a distinct disadvantage, although it has the same heating surface as Fig. 3. Hence, preference

*From a paper read at the North-East Coast Institute of Engineers and Shipbuilders in Sunderland, England.

should be given to a boiler which splits up the gases, leaving the combustion chamber, into small streams, and compels them to travel some considerable distance in contact with the heating surface before they pass away to the uptake.

As regards the fifth point, viz., the amount of water over the highest heating surface, the weight of water should be such as to allow the engines to run some little time with the feed shut off, as it will contribute a great deal to the comfort and peace of mind of the engineer if he knows that in case of a failure of the feed pumps he can run the engines some little time without burning the boiler.

As regards the sixth point, viz., accessibility for cleaning and repairs, and facilities for renewing damaged or defective parts, this is perhaps the most important point affecting the good working of the boiler. Absolute cleanliness of the heating surface is a necessity even for 150 lb. pressure, and in spite of feed filters and evaporators a certain amount of sediment and scale will find its way into a boiler so that it is very necessary to have every facility for cleaning. It is also very desirable that all parts of the boiler exposed to the heat of the furnace gases should be arranged to be conveniently renewed. All boilers are arranged to allow of re-tubing, but very few are arranged to allow of new furnaces being fitted, and in most cases a new combustion chamber means a new boiler. It is also desirable that the boiler should be arranged to allow of re-caulking all over, both inside and outside. All tubes should be straight, or nearly straight, and of the same length, otherwise a great number of spare tubes must be carried. They should also be of fairly large diameter, say not less than 2 in. This permits them to be examined from end to end.

As regards the seventh point, viz., provision at the bottom of the boiler of a quiet place where mud and grease may collect, a certain amount of mud and grease will get into a boiler, and it is well known that this is the most fruitful cause of collapsed furnaces. Hence, surfaces at the bottom of the boiler where grease could lodge should not, if possible, be exposed to heat.

As regards the eighth point, viz., the water circulation, this affects not only the good working of the boiler, but also the efficiency of the heating surface. In the first place, the circulation should be natural—*i. e.*, there should be no necessity for a pump or hydrokineter or other complications to compel the water to circulate. A free and natural circulation is especially valuable when raising steam, so that the whole of the water in the boiler may be practically the same temperature, and thus avoid racking strains on the boiler through unequal expansion. A good circulation on the water side of a heating surface is just as essential, and perhaps more efficient than a good circulation of the gases on the fire side. The most effective combination would be a moderate velocity of the gases and a great velocity of the water, and the water and gases moving in opposite directions. The best means of securing a maximum velocity of the water will be by vertical water tubes, as the entraining action of the steam bubbles will have free play.

As regards the final and most important point, that of cost, it was pointed out in the foregoing that, with 250 lb. pressure, under the most favorable conditions and with machinery costing not more than the present triple-expansion machinery, the saving in expenses on a boat of the size there specified would be 6 1-2 per cent. Whether this would be a good speculation remains to be discussed, but at any rate the engineer's choice of a boiler for 250 lb. pressure should be largely influenced by its cost of manufacture.

We can now proceed to discuss the merits of the various types of boilers.

Take first the ordinary cylindrical return-tube boiler. That it is capable of being worked at 250 lbs. pressure has already been demonstrated in the case of the screw steamer Inchmona. For this pressure, however, it is absolutely necessary to keep the diameter of the furnace as small as possible, hence some system of assisted draught is a necessity in order to burn the requisite amount of coal. The thickness of the material composing the heating surface will be considerably increased over the thickness required for 150 lbs. pressure, namely, the furnaces. by about 25 per cent, the fire-boxes and tube plates by about 10 per cent, and the stay tubes by about 50 per cent. To estimate the combined effect of all these different increases of thickness, as well as the effect due to the increase of temperature of the water, it is assumed that for the furnace and fire-box heating surface the heat transmission varies as the square root of the thickness of plate, and that the increase of thickness of the stay tubes has no appreciable effect upon the heat transmission.

The temperature in the furnace may be taken at 2,500 deg. Fah., in the firebox at 1,800 deg. Fah., and the mean temperature in the tubes at 1,250 deg. Fah.

Then for the furnaces we have,

$$\frac{(2500-366)^2}{(2500-406)^2}\times\sqrt{1.25}=1.16,$$

i. e., 16 per cent. less efficiency than under the lower pressure conditions.

For the fireboxes,

$$\frac{(1800-366)^2}{(1800-406)^2}\times\sqrt{1.10}=1.10,$$

i. e., 10 per cent. less efficiency than under the lower pressure conditions.

For the tubes,

$$\frac{(1250-366)^2}{(1250-406)^2}=1.09,$$

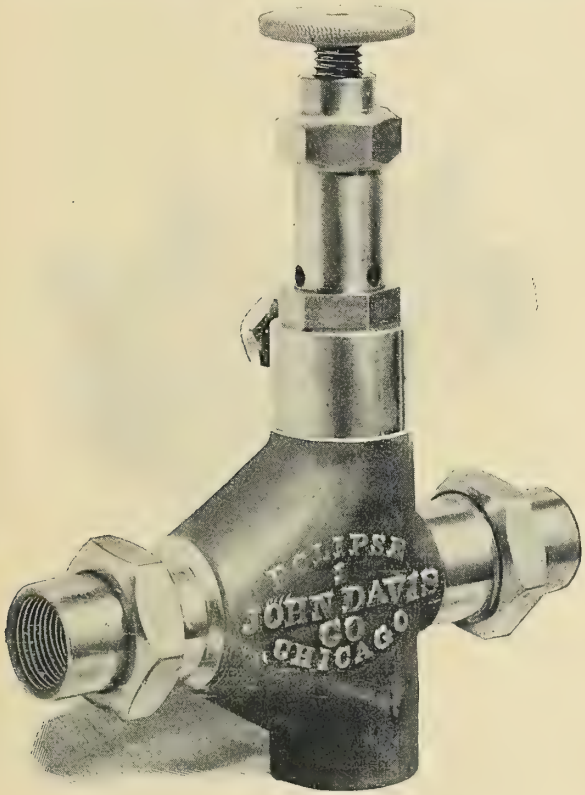
i. e., 9 per cent. less efficiency than under the low pressure conditions.

(*To be continued.*)

IMPROVED APPARATUS.

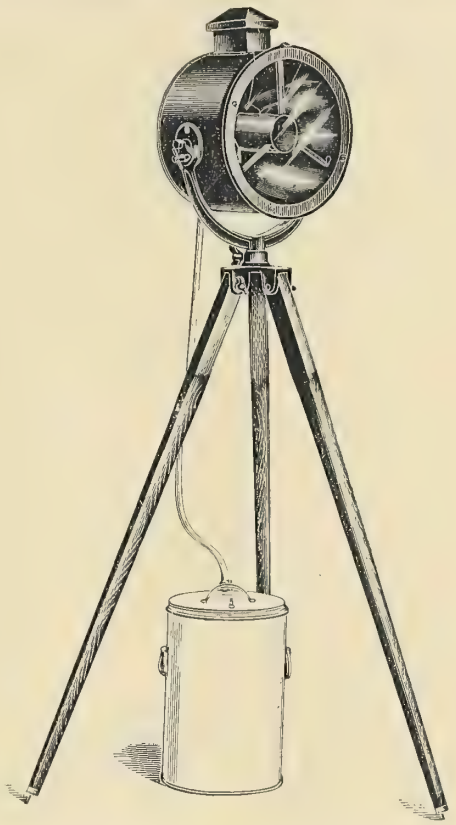
Acetylene Gas Searchlight for Small Boats.

The convenience of a searchlight is well recognized by those who have occasion to be under way at night. In making landings, in picking up buoys, in running up narrow channels or even in sailing close to the shore, it is indispensable. On small boats, however, owing to the lack of necessary apparatus for supplying current, it has hitherto been impossible to enjoy these benefits. Acetylene gas has now made possible the use of a searchlight in vessels unprovided with electrical apparatus. A light of sufficient intensity to illuminate objects within a radius of 600 feet is shown in the accompanying illustration. Here the searchlight is mounted on a light wooden tripod such as would be used by contractors or for railway purposes, work on fortifications and in mines, lighting lawns, etc., but it can be lashed to an eyebolt on deck. A special mounting is used on boats having a pilot house, so that the motion can be communicated to the light by the steersman inside the pilot house. One generator only is required for several searchlights if near together. The generator consists of two cylinders of proper proportions one within the other. The tank or outside cylinder is perfectly



ECLIPSE REDUCING VALVE.

plain; the gas-holder or inner cylinder is free to move within the tank, and in the top carries the carbide basket, which is introduced from underneath, and thus obviates the necessity of clamps or screw caps, which are always liable to leak. The condenser, of extra large surface for drying the gas, is at the lower part of the gas-holder. An outlet with "stop-cock" is provided for the gas. The overflow pipe prevents the gas from bubbling under the gas-holder, and consequent splashing of water on the floor. The gas-holder



AUTOMATIC ACETYLENE GENERATOR AND LIGHT.

is so arranged that the carbide is automatically raised out of or lowered into the water when the supply of gas is increased or diminished, and the pressure never rises over one or two ounces to the square inch. The generator will also light several lights in the cabin if desired at a cost of running, the makers state, of about one cent per hour. The searchlight and generator is manufactured by J. B. Colt & Co., 3, 5, and 7 West 29th street, New York.

Eclipse Steam Reducing Valve.

A new compact form of reducing valve for marine work, here illustrated, has been put on the market by the John Davis Co., of Chicago, and styled the "Eclipse." As will be seen by reference to the diagram there is no chance of rupture of a diaphragm, for it hasn't any, and there is also no stuffing box needing attention. The valve consists practically of one working part, which when set, will maintain a constant pressure in the flow irrespective of any rise in pressure in the supply pipe. The spring is entirely out of the steam, and consequently, when at work, is at a lower temperature than is likely to affect its temper. The address of the manufacturer is 51 Michigan St., Chicago.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.
S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representatives.
L. L. CLINE, Detroit, Mich., 47 Hodges Building.
B. M. GARDNER, Chicago, Ill., 1522 Monadnock Block.

Traveling Representatives.
E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:
Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

LAST month we published a list of the vessels of the Spanish Navy "brought down to date," and soon thereafter Admiral Dewey unceremoniously made it out of date. Courage, seamanship and gunnery skill won a glorious victory at Manila, and in seamanship we include the whole range of effort afloat, from the guiding mind on the bridge of the flagship Olympia to the least noticed passer in the darkest bunker in the fleet. Admiral Dewey commanded, the others obeyed, and so the fight was won. To bring our list up to date we might write across the names of these ships; sunk by American fire: Steel protected cruiser, *Isla de Cuba;* unarmored iron cruisers *Don Antonio de Ulloa* and *Velasco*, unarmored iron gunboats *General Lezo* and *Marques del Duero*, wooden cruiser *Castilla*, auxiliary cruiser *Isla de Mindanao*, the *Correo*, probably a small gunboat, and an unnamed transport. Besides engaging these vessels Admiral Dewey bombarded the fortifications at Cavite with the most extraordinary result of having no men killed or wounded in his fleet.

FOLLOWING the passage of the Naval Appropriation Bill there is evidence of a desire on the part of the Navy Department to promptly put into effect its provisions. The bill, as our readers will recollect, provides for the construction of three sea-going coast-line battle ships, four harbor-defense monitors, sixteen torpedo-boat destroyers and twelve torpedo boats, and also one gunboat to replace the "Michigan" on the Great Lakes. A circular has been issued by Secretary Long, for the information of intending bidders, defining the chief characteristics of the sixteen torpedo-boat destroyers and the twelve torpedo boats. This informs ship and engine builders that they are at liberty to prepare their own plans of hull and machinery to fit the general requirements of the vessels. They can, however, if they prefer, follow the plans and specifications of the Department or embody any part of these in their own designs. This latitude, which has previously been allowed by the Navy Department in the details of design and construction of high-speed boats, is very commendable. It is a recognition of the science, which is to be found in many yards, and experience which might dictate methods of obtaining results other than those adopted by the naval designers. But if originality is allowed in design, there are very rigid regulations regarding performance. Considering these, and the difficulties attendant upon the successful construction of, what are now considered, extremely high-speed vessels it will be well for bidders to carefully consider their facilities before competing. The general features of the two classes of vessels may be interestingly noted. The torpedo-boat destroyers are to have a displacement on trial between 400 and 435 tons, and to attain a speed of not less than 28 knots on two hours' trial. If on this trial the speed falls below the speed guaranteed by the bidders, the boat may be accepted at a reduction in price, at the rate of $8,000 for each quarter of a knot. Should the speed fall below 28 knots the vessel will be rejected. The destroyers will have twin-screws, water-tube boilers and bunker capacity for 100 tons of coal, which will be placed so as to give protection to the machinery. Each is to have two conning towers, the forward one to be of half-inch nickel steel plates. The battery, which will be provided by the Government and put in position by the contractor, will be composed of seven rapid-fire guns, the ammunition for which will weigh about seven tons. There will be fitted, also, two twenty-foot torpedo tubes on the midship line, and space below for stowing two spare torpedoes and four war heads. The berthing space will give accommodation for a crew of sixty men and four officers, with provision space for twenty days' supply. Lighting will be by electricity throughout, and a search light will be part of the equipment. The weights

to be carried on trial in addition to completed hull and machinery, with spare parts and fresh water necessary for trial, will be, in long tons: Ordnance, 15 tons; coal, 25 tons; crew, stores and equipments, 12 tons; or a total of 52 tons. The law provides that not more than five destroyers and not more than four torpedo boats shall be constructed in any one yard, or by one contracting party. In the regulations just issued the cost of destroyers may not average more than $295,000 each in any bid. This gives a maximum cost of about $702 a ton for the vessels completed. This is rather lower than the average of bids for the three destroyers contracted for by the Government last summer, which was in the neighborhood of $750 a ton. The twelve torpedo boats are to be within the limits of 150 to 170 tons trial displacement. They will also have twin-screws and water-tube boilers and bunker capacity for forty tons of coal. They are each to have two conning towers, the forward one of half-inch nickel steel. The battery of each boat will be composed of three rapid-firing guns, with about three and a half tons of ammunition, and on deck each will carry three fifteen-foot torpedo tubes. Stowage space will be provided for two additional torpedoes and five war heads. There will be a complete electric lighting plant on each boat, including a search light. There will be a berthing space for a crew of twenty-six men and three officers and provision space for twenty days' supply. The trial weights in addition to the hull and machinery ready for sea will include: Ordnance, 9 tons; coal, 10 tons; crew, stores and equipments, 8 tons; or a total of 37 tons. A minimum trial speed of 25 knots is demanded, or, should the boat fail to reach the speed guaranteed by the bidder, a penalty of $8,000 for each quarter knot will be exacted. In considering the bids submitted, the Department will give preference, other things being equal, to such designs as are best suited for the United States Naval Service, and among the matters of importance to be considered in this connection, according to the circular issued, are:

The highest practicable speed guaranteed.

Designs showing the best seagoing qualities and giving the best protection to engines and boilers.

Shortest time within which bidders will guarantee completion of vessels.

Plans and specifications are now being prepared by the Navy Department, and it will necessarily be some time before these are ready for bidders. When the plans and specifications are issued bidders will have three weeks in which to prepare their estimates and submit bids. All bids must state the date of completion of the vessels, and the maximum time limit is placed at eighteen months for destroyers and twelve months for boats. The Scotch price for the Spanish 400-ton destroyers was about $460,000 each.

CONSIDERING these new naval plans we are reminded that in some yards there is a disposition to sneer at "science" and exalt "practical experience." In the building of scows, harbor tugs, ferryboats, of what might be called the Colonial pattern and similar craft, science is probably a luxury, and luxuries don't go in the average shipyard. When a man has only to look up hull plans that his grandfather drew, and fish out engine patterns made during the Civil War, to fill his order, he doesn't need to bother with metacenter and stream lines, ratios of expansion and cavitation. Practical experience in throwing together the hull and machinery, running a trial trip, and getting his pay, is the need of this builder. Frequently, however, there is a buyer who wants an up-to-date vessel, and Uncle Sam is very choice in this respect. He will soon contract for as crack a lot of boats as ever kept a shipyard busy since Noah built the Ark. There is not a builder in the country, and mighty few out of it, who ever launched a 400-ton 28-knot boat. Where does the practical-experience man stand now? His practice does not extend to such vessels and his experience covers nothing of the kind. If he is wise he will admit to himself his need of the despised science, for science is experience ready made. It has no fight with practice, but simply supplements the art. Practice laughed at Froude and his duck pond, while today our Government is spending thousands of dollars on an experimental tank. Science is sometimes self-complacent and gives reason for experience to find fault. Science, not long ago, devised a method of balancing engines which works out beautifully in smooth water and atrociously in a seaway. Science needs art for ballast. The lack of a knot in the contract speed of one of the new destroyers represents $32,000, and though science comes high, this would buy a lot of it. The practical builder would do well to remember this, and also that science is modest and has to be sought, though there is lots of it between Fire Island and Point Reyes.

CORRESPONDENCE.

[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Reply to Inquiry About H. P. Diagrams.

In reply to the query of "Potomac" relative to his high pressure indicator diagrams, I send a sketch and table and a valve diagram. As to the data he gives,

STROKE 28″
TRAVEL OF VALVE=5¼″

	PRESENT		PROPOSED	
	TOP	BOTTOM	TOP	BOTTOM
LEAD	1/16″	1/16″	1/4″	11/32″
STEAM LAP	1 9/16″ f	1 9/16″ f	1 1/2″ f	1 7/16″ sc
EXHAUST LAP	0	3/8″	0	3/8″
CUT OFF	18 3/4″	16″	18 1/4″	16 1/2″
RELEASE	25 7/16″	25 9/16″	25″	24 7/16″
COMPRESSION	3 5/8″	3 5/8″	4 3/8″	4 1/8″

Marine Engineering

I believe the figure "2 inches" for the cut-off is certainly a mistake. The figure for the lead, viz., 1-16 inch top and bottom explains the whole difficulty with the diagram. At 102 revolutions, for an engine of this size, this amount of lead is entirely too small, and no amount of raising or lowering the valve is going to help matters. The only way to correct the difficulty is to shift the eccentric sheave of the Stephenson link motion. Assuming that the indicator gear was properly adjusted and that the card was carefully taken, the following Zeuner's diagram (Fig. 1) may be deduced from the card and the data given. This diagram shows that the steam opening does not take place until the crank is almost on the dead center. The dotted lines of the proposed setting show a lead of 1-4 inch on top and 11-32 inch on the bottom which is about right for that size of engine. Assuming that the distance between centers of the connecting rod is about 64 inches, the table shows the results deduced from the diagram. The proposed average cut-off remains the same as before, the release will be a trifle earlier, which is a decided advantage in a triple expansion engine, and the compression will be increased slightly, which will also be of advantage. The eccentric must be shifted back an amount equal to the angle P O R, which can easily be done by making an offset key. As the valve takes steam in the center, the eccentric follows the crank. At present the angle between the eccentric and the crank is P O N, and this must be reduced to R O N, also a small amount taken off of both steam laps of the valve as shown in sketch. (Fig. 2.)

It is very probable that the valve is fitted

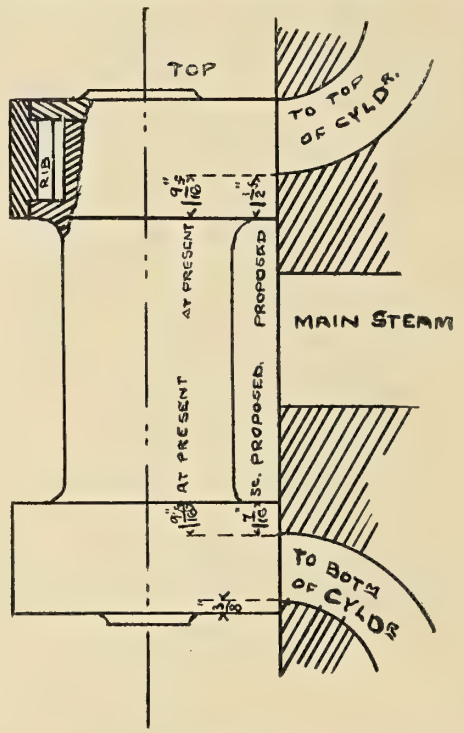


FIG. 2.

with spring rings, and that the cutting off edges are not sharply defined. These spring rings have long been abandoned on piston valves, as they have a tendency to wear the valve chamber out of round. Valves of this kind are usually altered as

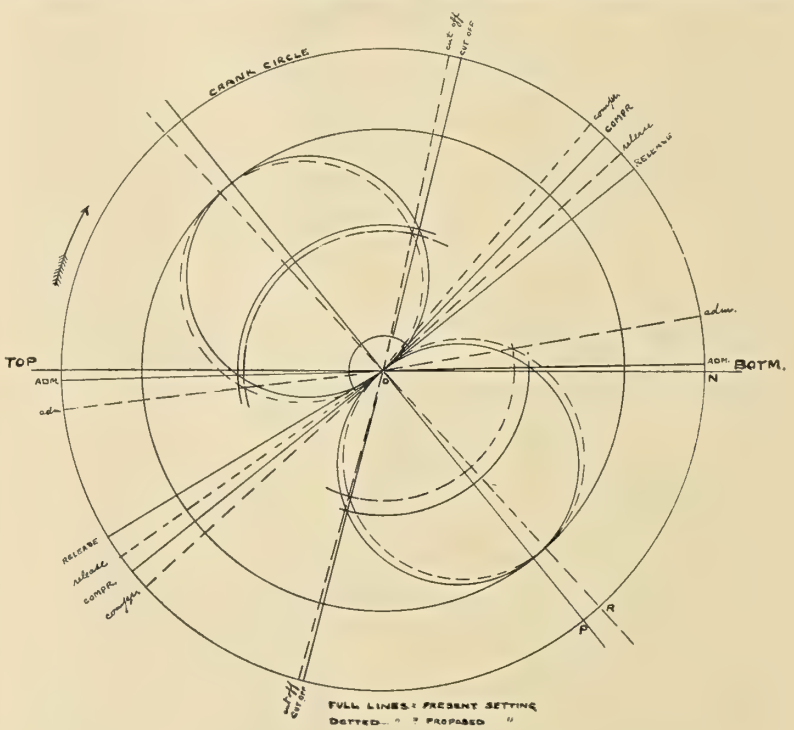


FIG. 1.

shown in sketch (Fig. 2). The cut-off lip on the valve and follower are turned off and a solid ring, with eight or ten ribs on the inner side, is put on with its edges overlapping, as shown, making a sharply defined cut-off edge. The follower holds the ring in place, allowing a slight side motion for adjustment if the valve stem gets out of center. If this type of ring is carefully fitted to a true chamber so that it will just jam when a narrow strip of one thickness of tissue paper is introduced with it at one side, the valve will run easy, and be steam tight for at least six years of steady service. H. L. EBSEN.

Replying to "Potomac," the diagrams show the valve has not sufficient lead. Again it may be possible that the valve gear is not as rigid as it should be, and when the engine is pinched over the centers, the valve shows, as he says, 1-16 in. lead, but when running at full speed the friction of the valve and gearing may cause it to be a little later each way, so that at such times there may be a little negative lead. Possibly the trouble may be caused by long and tortuous indicator connections.

If the valve gearing is the link motion with two eccentrics they can be set ahead a little, thus increasing the lead and at the same time give the needed improvement in compression.

The cut off must be 12 in. instead of 2 in., this evidently being a mistake.

SAM'L T. WILLIAMS.

A Query and Reply Concerning Estimated Weights.

The formulæ for estimating weights of machinery, by Professor G. R. McDermott, published in the February issue, are very interesting and instructive and would have been much more so had the pressure been taken into consideration. It is quite evident that two boilers of the same general dimensions, one constructed for a pressure of 100 pounds per square inch, and the other for 200 pounds per square inch, the one for the higher pressure must necessarily be much heavier than the other. The same thing is true with the engine. H. J. TEIPER.

REPLY.

Replying to Mr. Teiper, I beg to refer him to the remainder of my paper as read at the Society of Naval Architects and Marine Engineers in which I stated that, "The formulæ have been built up on current practice, triple expansion engines and boiler pressures from 150 pounds to 175 pounds. It is interesting to note, however, that they give a close approximation to the weight of compound engines, and pressures of 80 pounds to 100 pounds." Further on it is stated, "Unfortunately, sufficient data is not at hand of quadruple engines to allow of definite statements being made as to the probable increase in weight, but in a general way an increase of about 5 per cent. should be made on the engine room and boiler room weights as estimated by formulæ.' '

Apart from the above I may remind your correspondent that the weight obtained by use of formulæ, for both engine and boiler room weights, include a large number of items which are not affected by differences in boiler pressures. In seeking for a general formulæ I found, after repeated trials, that a representation of boiler pressure did not give any more accurate results, in fact there were greater differences observed between the weights of similar machinery built by different makers than existed between engines and boilers with a difference of pressures within the limits of 80 pounds to 250 pounds. I agree with Mr. Teiper in so far that in any formulæ for weights of separate items, such as boiler shell, cylinders, etc., pressure would demand attention, but its introduction into the general formulæ only renders it all the more complicated without yielding any more satisfactory results. GEORGE R. MCDERMOTT.

[The remainder of the paper, as referred to above by Professor McDermott, will be found, commencing on, page 20 of this issue.—ED.]

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—IX.

BY WM. BAXTER, JR.

Generators of the two pole type, such as described in the last three articles, are seldom used, except for small sizes, owing, mainly, to the fact that their output per pound of weight, or per unit of linear dimensions, is less than that of those constructed upon the multipolar principle. In the early days of the electrical industry, the two pole type became the favorite on account of its greater constructive simplicity, but when a demand for generators of several hundred horse power capacity began, the evident superiority of the multipolar machines won for them their well merited recognition.

The principles involved in the operation of two pole and multipolar, generators are the same, and the advantage of the latter consists in that a greater amount of work can be done by a machine of the same size; but it must not be inferred from this that the result can be obtained without increasing the size of the steam engine required to drive the generator. A two pole machine of high efficiency will transform into electric energy ninety per cent. of the power required to drive it, and a multipolar generator will not do any more. The advantage, therefore, is that if you have a combined engine and generator to do a certain amount of work, the total weight of the combination will be less if the generator is of the multipolar type, and in most cases the space occupied will be reduced. Why a multipolar generator can be made lighter than a two pole machine can be made clear by the aid of Figs. 46, 47 and 48, which are diagrammatic representations of a two pole, a four pole and an eight pole machine. In the four pole diagram, Fig 47, it will be noticed that the N and S poles alternate around the circle, and the same order is maintained in the eight pole type, Fig. 48. It will also be seen that so far as the field magnets alone are concerned, two adjoining poles with the portion of the outer rim that connects them form a complete magnet. Thus in Fig. 47 the top and the left hand poles constitute a complete magnet, and so do the top and the right hand pole; in fact, if we were to divide the machine along either one of the diagonal lines d d, or e e, we would have two complete fields, each one provided with one-half of an armature. If we bent the half armature around into a complete ring and stretched the rim b, connecting the poles, so as to bring them opposite each other, then we would have two complete two pole machines. By pursuing the same course with the eight pole diagram, Fig. 48, we could obtain from it four two pole machines. We may, therefore, regard any multipolar machine as made up of a number of two pole generators placed around the circle, with the armatures cut on one side and spread out so as to form parts of a larger ring. From this explanation of the principles involved in the construction of multipolar machines, we can also see that there are as many separate paths for the lines of force, or magnetic circuits, as there are poles, and that these pass through a smaller portion of the machine as the number of poles is increased, and therefore are shorter, as is clearly indicated by the line f in the three figures. Now the amount of wire required for the magnet coils will decrease as the length of the magnetic circuits is decreased, so that for Fig. 47 less wire will be required than for Fig. 46 and for Fig. 48 still less than for Fig. 47. The three figures are drawn to the same scale, and represent machines of the same capacity; therefore, the relative sizes and weights can be judged by a comparison of the proportions of the corresponding parts. The line f in Fig. 46 is about twice as long as in Fig. 47 and about four times as

long as in Fig. 48, hence the length of the iron part of the magnetic circuits in the three machines is nearly in the proportion of 1, 2, 4. But the air gap, that is the distance between the face of the pole and the surface of the armature core, is not reduced in the same proportion. It is in Fig. 47 more than one-half as much as in Fig. 46 and in Fig 48 more than one-fourth as much as in Fig. 46. The actual number of turns of wire in the coils of the three machines therefore will be about as indicated by the areas inclosed by their outlines. The diameter of the armatures and the width of their faces is the same in the three figures; therefore, it will be seen that although there are more than half as many turns of wire in each coil of Fig. 47 than in the coils of Fig. 46 the length of each turn is less, owing to the fact that the width a of the core is twice as great in Fig. 46 as in Fig. 47, hence the total length of wire in the two coils is more nearly in the proportion of 2 to 1 than would appear from the cross section alone.

As the armatures are of the same diameter, the number of turns of wire wound upon each will be the same, and if the velocity of rotation is the same the

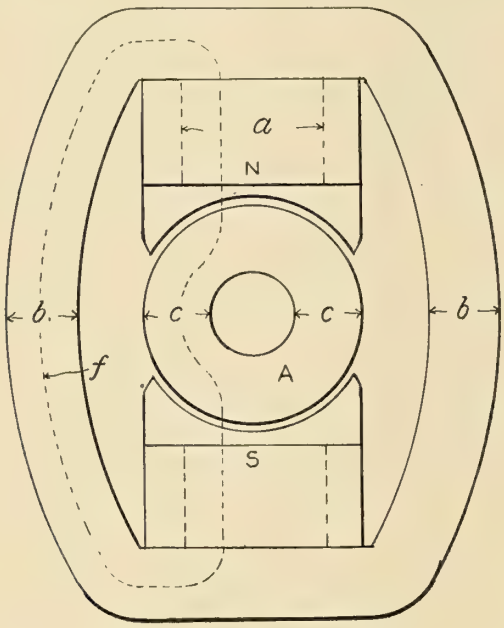


Fig. 46.

electro motive force developed will be in proportion to the number of lines of force in the magnetic circuits, and this number will be directly in proportion to the cross section of the magnets. In Fig. 46 the width c of each side of the armature core is equal to one-half of the width a of the magnet core, and as one-half of the lines of force pass around each side of the magnet frame, the sides are of a width b equal to one half of a, so that c and b are of the same section. In Fig. 47 a is equal to one-half of a in Fig. 46, and b and c are also equal to one-half of b and c in Fig. 46. Hence, the number of lines of force that will pass through each one of the magnetic circuits in Fig. 47 will be one-half as great as in each of the circuits in Fig. 46. In the latter figure there are two magnetic circuits, while in Fig. 47 there are four, from which we can see, by a simple multiplication, that the total number of lines of force in the four circuits of Fig. 47 is the same as the total in the two circuits of Fig. 46.

In Fig. 48 the width a of the magnet is one-quarter as great as a in Fig. 46, and this same proportion is maintained in respect to b and c; therefore, following the same line of reasoning as in connection with Fig. 47. we will find that in each one of the magnetic circuits of this figure the number of lines of force will be one-quarter of those in the magnetic circuits of Fig. 46, but as there are eight circuits instead of two, the sum total will be the same just as in Fig. 47.

From the foregoing we see that if the number of poles is doubled the number of lines of force passing through each pole can be reduced to one-half to main-

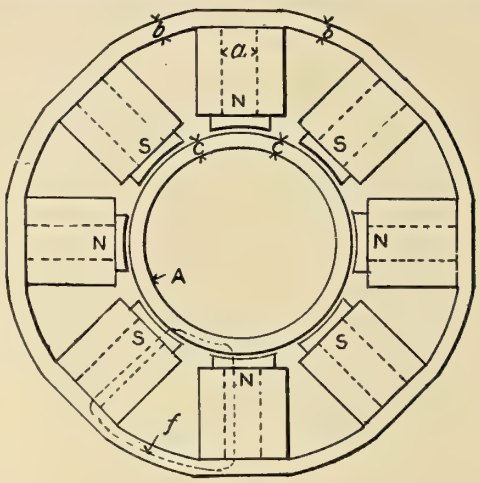


Fig. 48.

tain the same total number of lines in the entire machine. As the number of turns of wire on the armature remain the same, the electro motive force developed by the action of each pole will be directly in proportion to the number of lines of force passing through it; that is in Fig. 47 it will be one-half as great as in Fig. 46 and in Fig. 48 one-fourth. As the number of poles, however, acting in Fig. 47 is twice as great their combined effect will be the same as that obtained in Fig. 46 and in the same way the combined effect of Fig. 48 will be also equal to that of Fig. 46, because there are four times as many poles.

The wire on the armatures of Figs. 47 and 48 can be connected with the external circuit so as to develop the same voltage and same strength of current

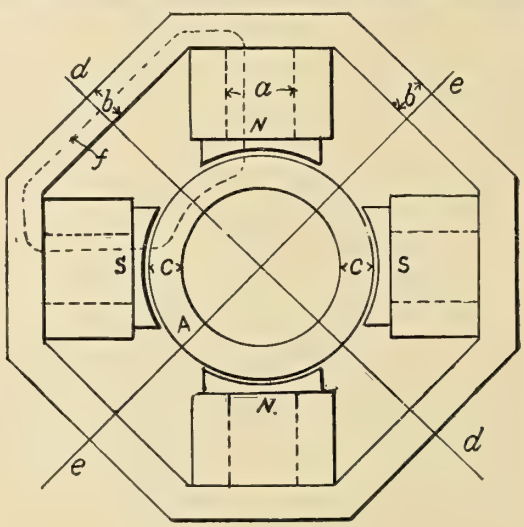


Fig. 47.

as is obtained from Fig. 46; or from Fig. 47 we can get one-half the voltage and twice the current strength, and from Fig. 48 one-quarter the voltage and four times the current strength. But whatever the combination may be, the energy of the current in

the three cases will be the same, and the relative sizes and weights of the machines will be in direct proportion to the difference shown by the proportions of the three diagrams.

From this explanation it will be seen that the greater the number of poles the smaller and lighter the machine for a given capacity, and if it were not for the fact that as the number of poles is increased certain mechanical and electrical difficulties begin to appear and grow with remarkable rapidity, it would be possible to obtain an enormous output from a very small generator by simply increasing the poles to a suitable number. One of the difficulties that is most easily understood is that in order to prevent sparking at the commutator it is necessary to have a large number of segments between each pair of brushes, and as the number of brushes is equal to the number of poles, the diameter of the commutator is increased as the number of poles is increased, and when this diameter becomes nearly equal to that of the armature, the limit is reached. It might be said that we could get around this difficulty by reducing the width of each commutator segment, but we cannot reduce it below a certain point because it must be wide enough to receive the end of the wire from the armature coil.

It will be noticed that if the cross sections at a, b and c of the field magnet and the armature are reduced in the proportion of 1, 2 and 4 the amount of wire required for the magnet coils will increase slightly as the number of poles is increased. This would not be desirable, as it would not only mean a greater expenditure for wire, but also a greater amount of electrical energy used in developing the magnetic field, and thus a decreased electrical efficiency. This difficulty is overcome, however, by leaving the amount of wire the same in each case, and increasing slightly the cross section of the iron to compensate for the reduction in magnetic density. If we desire to sacrifice the efficiency to obtain lightness, the iron cross section can be made in the ratio of 1, 2, 4, but if we desire to maintain the same degree of efficiency, the magnet coils are made so that the length of wire in each one decreases in the ratio of 1, 2, 4, and the reduction in field strength is made up by a slight increase in the weight of the iron parts.

The advantages derivable from the adoption of a multipolar construction can be utilized either to reduce the weight of the machine or its velocity, or a midway course can be adopted and the gain be divided between reduction in weight and in speed. Two pole generators run, generally, at velocities ranging from about 700 revolutions per minute, for the largest sizes, to 2,000 and even more in small machines. Multipolar generators, however, are run at speeds between 1,000 and 100, or even less. These machines are driven either by means of a belt or by being connected directly to the shaft of a steam engine. When of the belt type the speed may range from about 500 for large sizes to 1,000 for the smallest; but when directly connected with a steam engine the velocity is controlled by the speed at which the engine can run safely. Generators that require from 50 to 200 horse power are connected with high speed engines that run at a speed ranging from 200 to 300 revolutions per minute. If the power is greater than 200 or 300 horse power, the revolutions will be below 200, dropping as low as 80 or 100 for generators that require from 1,500 to 3,000 horse power.

From the foregoing it will be seen that in small machines the gain effected by using the multipolar construction is utilized principally in reducing the weight, while in large ones it is utilized to reduce the speed of rotation. If it were not for the increased capacity of multipolar machines, per unit of weight, large generators of slow speed could not be made, and even if of such velocities as would be permissible, their dimensions as well as weight would be much greater than that of those now in use.

The general proportion of the various parts as shown in Figs. 47 and 48 are not followed in the generators actually constructed, as they are not as compact as they might be. The figures have been drawn in this skeleton fashion so as to clearly present to the eye the difference in size of machines of equal capacity, but with different number of poles. By properly condensing the design the space occupied is considerably reduced, but no additional gain is affected in the weight, and in fact in some cases the weight is actually increased a trifle. In the next article we will give an explanation of a number of the most prominent types of multipolar generators.

QUERIES AND ANSWERS.

Q. Would you kindly give the length and breadth of the hull of the "Great Eastern," and the dimensions of her engines? VACUUM GAUGE.

A.—The following particulars of the steamship Great Eastern are from the most authentic sources: She was built by Scott Russell & Co., of London, who also had the contract for the paddle engines. The contract for the screw engines was let to James Watt & Co., of Birmingham. Work was commenced on the hull early in 1854, and she was ready for launching late in 1857. The effort to launch her then was not successful, and she was not afloat until January, 1858, the expenses of launching having been about $500,000. She was built of iron, and fitted with a single screw and side wheels. Her dimensions were: Length, 692 ft.; beam, 82 ft. 6 in.; depth from main deck, 58 ft.; gross tonnage, nearly 19,000 tons; displacement at 30 ft., 30,000 tons. She was flush decked, had four decks, and a double bottom, which was carried up above the water line. The upper deck was cellular.

The propelling engines were simple, the working pressure being about 20 lbs. per sq. in. The paddle engines had four cylinders, each 74 in. dia. and 168 in. stroke, making about 25 revolutions per minute and indicating about 3,500 horse power. The screw engines were horizontal simple engines, with four cylinders 84 in. dia. and 48 in. stroke, run at about 55 revolutions and indicating about 4,500 horse power. There were ten multi-tubular double-ended square box boilers, 18 ft. long, 17 ft. 6 in. wide and 14 ft. high, with 112 furnaces in all. She burned about 300 tons of coal a day, and averaged anywhere from 13 knots to 15 knots, according to conditions. The side wheels were 56 ft. dia., and the propeller wheel 24 ft., with a pitch of 44 ft.

During her active life the Great Eastern made nearly a dozen passages across the Atlantic with passengers and cargo. Mechanically she was a great success, but commercially a failure, and she was broken up a few years ago on the beach in the Mersey, opposite Liverpool, after having passed through many ownerships.

Q.—My engine has two 5 in. by 6 in. high pressure cylinders, cuts off steam at 5-8 in. stroke, and turns 400 revs. per minute with 200 lbs. steam in the boiler. What size should cylinders of a triple-expansion engine be to be furnished with steam from the same boiler? What would be the gain in power, or, how much faster would the triple-expansion engine drive a boat 65 ft. by 8 1-2 ft.? D.

A.—Assuming that your boiler has power enough to turn your engine continuously at 400 revolutions with about 200 lbs. gauge pressure, and that the engine is of ordinary design, you are probably getting from 60 to 70 indicated horse power. If you substitute for this engine a triple-expansion condensing engine of good design, you should nearly or quite double the power on the same expenditure of steam. This would give with the same boiler capacity a power of, say, 130. Keeping revolutions the same at 400, an engine 6 in., 9 1-2 in. and 15 in. by 9 in. stroke would be appropriate to develop this power with good economy. Such an engine would, however, be rather large for your boat unless you wish to sacrifice all considerations for speed, and you might presumably do better to put in a smaller engine and be content with a moderate power, and the corresponding saving in coal. Thus for about 100 I. H. P. at 400 revolutions the sizes might be 5 3-4 in., 9 in. and 14 in. by 8 in. stroke, or for about the same power as you are now getting you could use 5 in., 7 1-2 in. and 11 1-2 in. by 8 in. stroke.

The full increase of power would probably add about 25 per cent to the speed of the boat, while 100 I. H. P. would probably add some 12 or 14 per cent. In any case, if the power is increased and revolutions kept the same, a new propeller would be required. If it were desired to retain the same propeller, the revolutions would have to be increased accordingly, and this would in turn change entirely the appropriate sizes of cylinders and stroke. The revolutions are already sufficiently high, and it is probable that the best results would be obtained by fitting a new propeller with the new engine.

Q.—I would thank you for any information you can give me about bilge keels. What effect would they have in steadying a vessel in a seaway? Would there be change of speed with bilge keels? What length and how wide a flange would a yacht, 98 ft. long on the water line, 13 ft. beam and 6 ft. draught, require to steady her in a seaway? S. H. D.

A.—Bilge keels, if properly fitted, may be expected to accomplish results somewhat as follows:

(1.) If the vessel were set rolling in still water with a given degree of roll, the bilge keels would reduce the number of sensible oscillations to perhaps one-third or one-fourth their number without the keels.

(2.) Among waves the bilge keels may be expected to reduce the extent of average roll to one-half or two-thirds its value without the keels. If the ship should fall in with waves of a period nearly the same as her own natural period of roll, the bilge keels will produce relatively less reduction in the extent of roll.

(3.) The period, or length of time occupied by a roll, is usually lengthened by an amount not far from 5 per cent.

(4.) These effects of bilge keels will be more pronounced as the midship section is more round, and less pronounced as it is more square or fuller on the bilge.

(5.) If properly fitted the keels will not affect the speed to an appreciable extent. Recent experiments show that presumably not more than two or three per cent. of the power is required to overcome the added resistance, and at moderate speeds, even less than this. The consequent effect on the speed would be less than one per cent.

(6.) Appropriate size of keels for a yacht such as the one you describe would be 50 to 60 feet long and from 9 to 12 inches wide. The effect will, of course, be more pronounced as the keel is wider.

Q.—I read with great interest the very clear explanation of boiler bracing in your last issue, and if you would add to this instructions how to figure out the safety valve problem, I believe you would interest, not only myself, but hundreds of other engineers. S.

A.—The arrangement of a weighted arm safety valve is shown in skeleton in Fig. 1. The steam presses upward on the lower face of the valve V, and is opposed by three forces tending to keep the valve on its seat as follows: (1) The weight of the valve and spindle direct. (2) The weight of the lever with center of gravity at some point N and pivoted at the fulcrum O. (3) The weight proper at M acting with a leverage or arm equal to M O.

Now just as the valve is about to open, these two sets of forces, the one acting upward and the other acting downward, will balance. It is furthermore a principle of mechanics that when such forces are just on a balance, the product of the

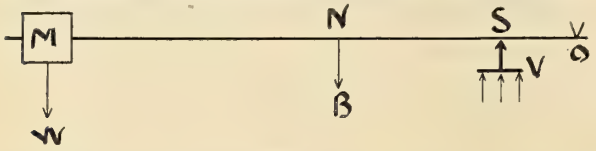


Fig. 1.

forces by their arms or leverages must make the same sum in each direction. Thus in the present case the up forces may be considered as tending to cause motion about the fulcrum O, and the down forces as tending to oppose motion about the same point. We therefore measure our arms from this fulcrum point O.

Now if A is the area of the valve in square inches and p the steam pressure in pounds per square inch by the gauge, the total steam load on the valve will be the product $p \times A$. This acts directly upward, and, as noted above, is directly opposed, as far as it goes, by the weight of the valve and spindle. Denote this by V. Then the difference $(p \times A - V)$ is the actual or net force transmitted from the valve to the lever at S, and thus tending to produce motion of the lever upward. Let a denote the arm for this force, or the distance S O from the center of the spindle to the center of the fulcrum. Then $(p \times A - V) \times a$ is the product of force by arm for the upward forces. Let us save this and turn next to the remaining downward forces. Let W denote the amount of weight at M and l the arm or distance M O; also B the weight of the lever and c the arm N O or distance from the center of gravity of the lever to the fulcrum. Then $W \times l + B \times c$ is the sum of the products for the downward forces. By condition these must be equal. Hence as an equation we shall have:

$$W \times l + B \times c = (p \times A - V) \times a$$

or

$$W \times l + B \times c = p \times A \times a - V \times a$$

From this equation we can find the value of any one quantity which we may wish, provided we know all the others. Thus suppose we know all but W. Then we have:

$$W = \frac{p \times A \times a - V \times a - B \times c}{l}$$

Similarly if we know all but l we have:

$$l = \frac{p \times A \times a - V \times a - B \times c}{W}$$

and if we know all but p, the pressure at which the valve will open with a given weight and location, we have:

$$p = \frac{W \times l + B \times c + V \times a}{A \times a}$$

We can readily express by rules the operations represented by these equations as follows:

Rule (1). To find the weight, knowing the other quantities.—Multiply together the pressure per square inch, the area of the valve in square inches, and the distance from the center of the valve spindle to the center of the fulcrum. From this

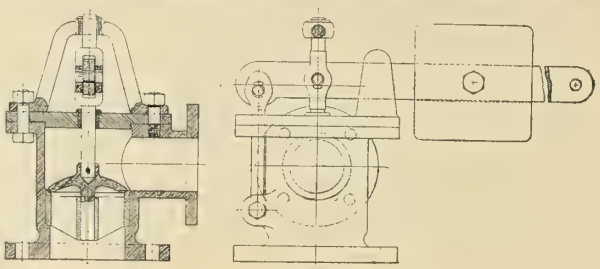


Fig. 2.

subtract the product of the weight of valve and spindle by the same arm S O, and also the product of the weight of lever by its arm N O. Divide the remainder by the weight arm M O, and the quotient will be the weight desired.

Rule (2). To find the location of the weight or length of arm M O, knowing the other quantities.—Find the same difference as in rule (1) and divide by the weight W. The quotient will be the length of the arm M O.

Rule (3). To find the pressure at which a given valve and weight will lift.—Multiply the weight W by its arm M O; also the weight of the lever by its arm N O, and the weight of the valve and spindle by its arm S O. Add these three products and divide the sum by the product of the area of the valve by the arm S O. The quotient will be the pressure desired.

Illustrative example:

Let M O or l = 28 in.
" N O or c = 12 in.
" S O or a = 4 in.
" Diam. of valve = 3½ in.
Then Area of valve or A = 9.62 sq. in.
Let Weight of lever or B = 5½ lbs.
" Weight of valve or V = 4 lbs.
" Steam pressure or p = 80 lbs. per. sq. in.

Then,

$$p \times A \times a = 80 \times 9.62 \times 4 = 3078.4$$
$$V \times a = 4 \times 4 = 16$$
$$B \times c = 5\frac{1}{2} \times 12 = 66$$

Then,

$$3078.4 - 16 - 66 = 2996.4 \text{ and } W = \frac{2996.4}{28} = 107 \text{ lbs.}$$

in round numbers. Or if W were known and l required, we should find the same numerator, 2996.4, and then have:

$$l = \frac{2996.4}{107} = 28 \text{ in. in round numbers.}$$

Of if p is desired we should have:

$W \times l$		107	×	28	=	2996
$B \times c$	=	5½	×	12	=	66
$V \times a$	=	4	×	4	=	16
	Sum	- - - - - - - - -			=	3078
$A \times a$	=	9.62	×	4	=	38.48

We then have:

$$p = \frac{3078}{38.44} = 80 \text{ lbs. in round numbers.}$$

The U. S. regulations relating to safety valves will be found on pp. 36, 37 and 38 of the Rules Prescribed by the Board of Supervising Inspectors of Steam Vessels, issue of 1896, and you would do well to obtain a copy of these rules from the Supervising Inspector General of Steam Vessels, Treasury Department, Washington. You can then study up for yourself the details of the lever safety valve and fittings as therein prescribed, as well as the various rules and regulations relating to boilers, pumps, piping, etc., as prescribed by United States law.

The form and general proportions of lever safety valve recommended by the U. S. Board of Supervising Inspectors are shown in Fig. 2.

ENGINEERS' DICTIONARY.—V.

Boiling Point.—The degree of temperature at which boiling takes place. This varies with the pressure on the surface of the liquid, being at 212° on the Fahrenheit scale for atmospheric pressure, at 102° for 1 lb. pressure absolute or 13.7 lbs. vacuum, at 382° for 200 lbs. pressure, etc. Tables giving these temperatures are provided in text-books and hand-books relating to steam and the steam-engine.

Bonnet.—A small plate or cover closing the opening over a valve chamber and by its removal allowing the examination and repair of the valve. Also often used less exactly in reference to any small removable cover closing an opening.

Brace.—In general an auxiliary member intended to connect the principal members of a structure and to give them such support as they may need, additional to that provided by their own strength, as in the framing of an engine. See also under *Boiler.*

Brass.—As a material, an alloy of copper and zinc in about the proportions of two parts of copper to one of zinc. Its strength is not far from that of cast-iron, but it is much less brittle. It is much used where somewhat greater toughness is desired than can be furnished by cast-iron, and also where corrosion is sought to be avoided, and where its greater first cost is not a serious objection. It is also used to a considerable extent as a bearing metal. The two parts of a bearing, especially when of brass, are often called the upper and lower or *top* and *bottom brasses,* while together they are simply called the *brasses.* The same parts are also sometimes known as boxes, either referring to the bearing as a whole, or to the brasses alone.

Brazing.—The operation of joining two metals by means of *brazing solder,* or *hard solder,* as it is sometimes termed. The surfaces to be joined are cleaned, bound together with wire or otherwise, supplied with brazing solder in small bits mixed with borax as a flux, and placed in a clear fire until the alloy melts.

Brazing-Solder or *Hard-Solder.*—Usually a brass or alloy of copper and zinc, and so proportioned with regard to the metal with which it is to be used that the melting point of the latter is the higher of the two, in order to insure the melting of the solder without endangering the metals to be joined.

Brazed-Joint.—A joint made by brazing. All copper piping with its branches, tees, elbows, connections, etc., are made from sheet copper with brazed joints. The operation is one involving a considerable amount of skill, if done correctly.

Breeches Pipe.—A pipe separating into two legs or branches of equal size and running parallel or slightly diverging.

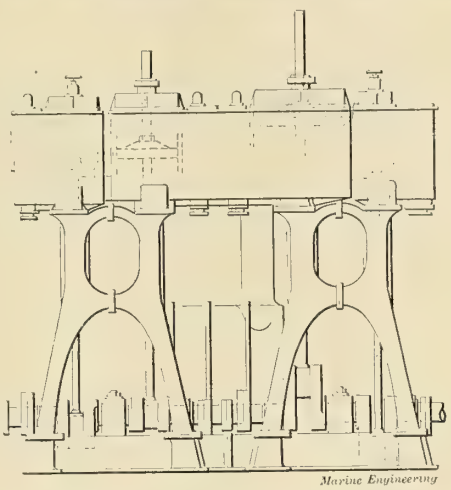
Bridge-wall.—See *Boiler.* A wall of fire brick placed at the back of the grate thus furnishing a back limit to the fire, and providing at this point a decrease in the size of the passage for gases into the combustion chamber. The object of this decrease, which is similar to the throat of an ordinary chimney, is to give to the products of combustion at this point a definite and pronounced velocity from the furnace to the combustion chamber.

Bridle-rods.—The term *suspension bar or rod* is a general name for any bar connecting the link of a Stephenson valve gear with the rock-shaft arm, and serving for its support and control as in reversing or linking up. *Bridle-rods* are a particular example of this mode of support in which they are two in number, one on either side with the link between. Often, however, the term is used more vaguely to denote any rod serving to support or control the link of a valve gear.

SELECTED PATENTS.

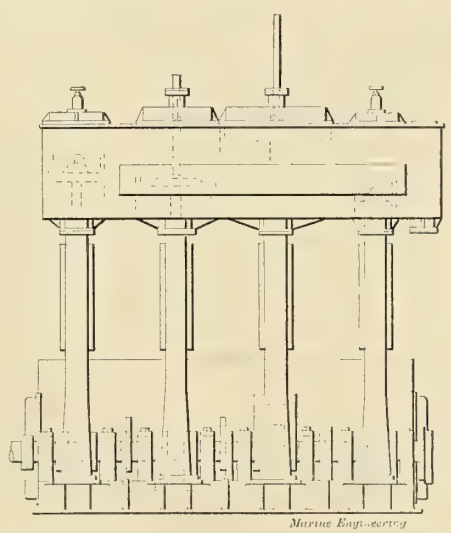
594,289. Balancing of Steam or Like Motive-Power Engines. *Ernst O. Schlick, Hamburg, Germany, assignor to the Yarrow, Schlick & Tweedy System, Limited, London, England. Filed Sept. 6, 1895.*

In a steam or like motive-power engine, the combination with the cylinders arranged side by side with their longitudinal axes at predetermined distances apart, and the moving elements of said cylinders,



namely their pistons and parts reciprocating therewith; of a shaft having four cranks acted upon by said moving elements set at different angles, the angular relation of said four cranks varying in accordance with and being determined by their length, the distances between them, the weights of the aforesaid moving elements and the finite length of the connecting-rods to balance the reaction forces acting upon the crank-shaft and engendered by the weight of said moving elements and resulting from the finite length of said rods.

In a steam or like motive-power engine, the combination with cylinders of different diameters arranged



side by side with their longitudinal axes at predetermined distances apart, and the moving elements of said cylinders, namely their pistons and parts reciprocating therewith; of a shaft having four cranks acted upon by the said moving elements set at differ-

ent angles, the angular relation of said four cranks varying in accordance with and being determined by their lengths, the distances between them, the weights of the aforesaid moving elements and the finite length of the connecting-rods to balance the reaction forces acting upon the crank-shaft and engendered by said moving elements and resulting from the finite length of said rods.

In a steam or like motive-power engine, the combination with cylinders of different diameters arranged side by side with their longitudinal axes at predetermined distances apart, the cylinders of greater diameter between those of less diameter, and the moving elements of said cylinders, namely their pistons and parts reciprocating therewith; of a shaft having four cranks acted upon by said moving elements set at different angles, the angular relation of said four cranks varying in accordance with and being determined by their lengths, the distances between them, the weights of the aforesaid moving elements and the finite length of the connecting-rods to balance the reaction forces acting upon the crank-shaft and engendered by said moving elements and resulting from the finite length of said rods.

In a steam or like motive-power engine, the combination with the cylinders arranged side by side with their longitudinal axes at predetermined distances apart, the moving elements of said cylinders, namely their pistons and parts reciprocating therewith and the valve-gears; of a shaft acted upon by said reciprocating elements and valve-gears and having four cranks set at different angles, the angular relation of said four cranks varying in accordance with and being determined by their length, the distances between them, the weights of said moving elements and valve gears and the finite length of the connecting-rods, to balance the reaction forces acting upon the crank-shaft and engendered by the weight of said parts and resulting from the finite length of the connecting-rods.

NEW PUBLICATIONS.

Gas, Gasoline and Oil Vapor Engines. By Gardner D. Hiscox, M.E. Norman W. Henley & Co., 132 Nassau street, New York. Second Edition. Size, 6 by 9 1-2. Pages, 365. With 270 Illustrations. Cloth, $2.50.

The second edition of this work, which has been very favorably received, is just out. It aims to give a complete knowledge of the theory and design, as well as the construction and operation, of internal combustion engines as displayed in American practice. This includes, of course, various types of engine of foreign invention manufactured here by arrangement with the original patentees. The greater part of the volume is taken up with matter relating to stationary engines, but there is considerable attention given to motors for boats and horseless carriages. Altogether it is a very useful book for the consulting engineer, as it contains within its covers matter which can only be had independently in the files of technical papers, and literature issued by many manufacturers, and in foreign works on the subject.

Marine Engineers *and How to Become One*, with Notes on the Board of Trade Examinations. By E. G. Constantine, M.I.M.E. The Technical Publishing Co., Ltd., Manchester, 1898. Size, 5 by 7½. Pages, 312. With Illustrations. Cloth, 5s.

The real purpose of this book is to inform any young man with a taste for sea service about the duties, responsibilities and opportunities of the seagoing marine engineer. It is written for British youth and so contains much matter which, though interesting enough, is not of material censequence to Americans. The subject is handled in an orderly way, commencing with an explanation of the British system of apprenticeship and concurrent scientific education, then follows a history of the marine engine, a series of chapters on the duties of the seagoing engineer, and a number of useful hints on the repair of breakdowns at sea, and finally much information about obtaining certificates from the British Board of Trade. The author's history of the marine engine, which deals principally with the Atlantic trade, is one of the best condensations of the subject we have read. There are a number of excellent illustrations in the text. The author has a good, clear style, and the book is of real interest throughout, and contains much information of value.

Reed's Useful Hints to Sea-Going Engineers, *and How to Repair and Avoid Breakdowns.* Also Appendices Containing Boiler Explosions. Useful Formulæ. Thomas Reed & Co., Sunderland. Third Edition, 1898. Size, 5 to 7 1-2. Pages, 248. With 42 Diagrams and 8 Plates. Cloth, 3s., 6d.

The publishers of this book are responsible for several really good, practical works on marine engineering subjects which have had a large sale. The "Useful Hints" is a very excellent example of their work. It is intended, as the title indicates, for sea-going engineers, who will, presumably, in the course of a voyage be far remote from any sort of workshop-facilities. The extensive instructions and illustrated suggestions for the treatment of breakdowns are especially valuable for men who are in such ships, but there is often need for considerable skill in cases of mishap in home waters. The various examples given are all the more valuable, as they are chiefly accounts of actual repairs effected on vessels, and not merely imaginative. No book could be published which would give instructions for all possible mishaps, no more than any book on operative surgery could adequately equip any surgeon for emergency work. Engines have a peculiar knack of giving out in the oddest places and ways imaginable, and not only this, but the conveniences and material for repair may differ vastly in different ships, even where the same sort of breakdown has to be handled. Besides the emergency work there are many pages of Useful Hints, when things are running smoothly, which can be read very profitably, especially by subordinates who expect to fit themselves for higher command. The book is extremely simple, practical and readable.

An official announcement of the death of Thomas F. Dowd, national secretary of the Marine Engineers' Beneficial Association, has been made by George Uhler, the national president, under date Chicago, May 21, in these words:

To the order wherever found, greeting:—With a feeling of profound sorrow, I announce the death from pneumonia, after an illness of only six days, of Brother Thomas F. Dowd, national secretary, at his home in this city at 9.30 A. M., Thursday, the 19th instant. It is not my desire at this time to enter into any detailed eulogy of the official life and services of our deceased brother, but with a sincere appreciation of his untiring zeal and interest in the affairs of the organization with which he has been officially connected for so many years, I simply make this brief announcement. The national president will be in Chicago for some days in connection with the office made vacant by the demise of our brother. Any important communications can be addressed to the Sherman House, Chicago. To fill out the unexpired term of our late Brother Dowd, I have this day appointed as National Secretary Brother George A. Grubb, of M. E. B. A. No. 4, whose address will be No. 1537 George street, Station B, Chicago, to whom all communications should be addressed, and to whom all remittances should be forwarded.

TRADE PUBLICATIONS.

"Why and How to Use Red Lead" is a pamphlet 6 by 9 in. in size and comprising 30 pages, issued by the National Lead Co., 100 William St., New York. It is written by Ralph K. Wing, who has made a special study of the subject in question.

Linenoid seamless boats and canoes are well illustrated and described in a 3 by 6 in. catalogue issued by Crane Bros., Westfield, Mass. These boats are made in various sizes and styles and any length up to 17 ft. Users of small boats will appreciate having one of these catalogues.

A patriotic panel in color entitled "Our Country's Standard" is received from the American Steam Gauge Co., 36 Chardon St., Boston, Mass. It is about 14 by 26 in. in size and represents a sailor lad hoisting the American flag, the flag being in colors and very well executed. Duplicates can be had upon application to the company.

Persons interested in water-tube boilers should send for a copy of the little pamphlet just issued by the Boyer Patent Sectional Water-Tube Boiler Co., 90 Wall St., New York. It gives three excellent illustrations of the boiler built by this company and installed on the steam freighter "Clara." The "deadly parallel" shows a remarkable efficiency of the boat with the new boiler.

The Palmer gas and gasoline engine is illustrated and described in a catalogue just received. The marine type is familiar to readers of Marine Engineering and is fully described in this catalogue. The catalogue also contains considerable information regarding the launches of various types sold by this company. Also a line of auxiliary appliances, such as propeller wheels, boat trimmings, etc.

The 1898 catalogue issued by the Lee-Penberthy Mfg. Co., Detroit, Mich., is just received. It is 5 by 8 in. in size and is a manual of useful and valuable information, comprising discount tables, pipe tables, railroad distances, and much other matter convenient for users, sellers, and manufacturers of steam goods. Several full-page illustrations are given of the Lee-Penberthy injectors manufactured by this company.

Sturtevant Engine Catalogue No. 103 is the latest publication by the B. F. Sturtevant Co., Boston, Mass. It comprises 45 pages, beautifully printed on coated paper, with a cover of rich dark green neatly embossed in light green and gold. The title to the catalogue tells the whole story of its contents, which include illustrations of the many types of this engine, with full descriptions, sectional drawings, and a great deal of valuable information which will interest every man who has to do with steam engines.

Two catalogues are received from the Weber Gas & Gasoline Engine Co., Kansas City, Mo. One of these is devoted to the engines manufactured by this company which are adapted to all kinds of uses in which small power is called for and the other one to the hoisting engines manufactured by this company. These hoisting engines have become very popular for use on wharves and docks, as well as on many vessels where any kind of hoist is required.

Marine specialties manufactured by the De La Vergne Refrigerating Machine Co., foot of East 138th St., New York, are fully described in a 40-page catalogue just received. These specialties include a line of hoisting engines designed for all uses, from small hoists up to large floating derricks. Various types are illustrated and fully described, and several tables give necessary sizes, prices, and other information. The hoists are either electric or steam, or can be operated by the Hornsby-Akroyd oil engine manufactured by this company. Another specialty which this company now handles is the Brownley injector.

BUSINESS NOTES.

OFFICE REMOVED.—William Craig, whose office was formerly at 42 Cortlandt St., New York, can now be found at 121 Liberty St., where full information can be obtained regarding his stop valve, feed-water circulators and other specialties.

BALL BEARING CO.'S NEW YORK OFFICE.—The Ball Bearing Co., Watson St., Boston, Mass., has been obliged, in order to secure improved facilities, to move its New York office from the American Tract Society Building to 121 Liberty st., where any information regarding roller and thrust bearings can be readily obtained.

MARINE ICE PLANTS.—The International Navigation Co. (American Line) has just ordered from the Kilbourn Construction Co., Drexel Building, Philadelphia, two refrigerating machines for use on one of its steamers. This makes thirty-six Kilbourn machines in use on the various boats of this line and is a high compliment to their efficiency.

COPPER TUBING.—Users of copper tubing will be interested in the picture shown in the advertisement of Randolph & Clowes, Waterbury, Conn., which gives some idea of the large sizes of tubing manufactured by this company. This company makes a specialty of condenser and other seamless copper tubes especially designed for marine work.

PIPE WRENCH.—The Brock pipe wrench, manufactured by J.H. Williams & Co., 9-31 Richards street, Brooklyn, N. Y., is a device that every engineer will value for use in his engine-room. The pictures of this wrench, shown in the advertisement of the company elsewhere in this issue, will show the design of this wrench and the grip that it must of necessity have.

HYDE WINDLASSES.—Many vessels recently constructed, both in the various departments of the Government and the merchant marine, as well as yachts, are introducing the Hyde windlass and capstan manufactured by the Hyde Windlass Company, Bath, Me. The fact that the people connected with this company are practically the same as those connected with the Bath Iron Works, the quality of whose workmanship is well known, is sufficient guarantee as to these windlasses and capstans.

COPPER COMPOUND COMPOSITION.—The anti-friction metal manufactured by the Standard Smelting Works, 172 Hudson St., New York, and known as their anti-friction metal copper compound, possesses many features of interest to users of such metal. A letter received by this company from the Chrome Steel Works of Brooklyn says: "We have used your composition on the pinion bearings of our 26 in. plate train, where it has been subjected to a thorough test, and will frankly say it has given better satisfaction than any metal we have heretofore used." The Standard Co. is prepared to send any information regarding this metal to all inquirers.

SEAMLESS STEEL TUBES.—The Shelby Steel Tube Company, Cleveland, Ohio, which has recently acquired the interests of a number of the largest seamless tube mills, both in Pennsylvania and Ohio, has secured a large contract from the United States Navy Department for boiler tubes. These tubes are of seamless cold-drawn steel, 21-4 in dia., by 9 gauge. All of the tubes are upset on one end. It is understood that this order comprises a full set of tubes for all of the boilers for the Iowa, Brooklyn, Cincinnati, Bennington, and a partial set for the Texas. These tubes are to be delivered within sixty days. The Shelby Steel Tube Company is thoroughly equipped for doing this class of work. This order is of interest, inasmuch as it is the first time in years that the Navy Department has taken steel tubes in preference to lap-welded charcoal iron tubes.

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO.,
JERSEY CITY, N. J.

REDUCING VALVES

to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.

THE SCHOOL FOR MARINE ENGINEERS,

AMERICAN SCHOOL OF CORRESPONDENCE.
(Chartered by Commonwealth of Massachusetts.)

TEACHES ONLY— **ENGINEERING** { STEAM, ELECTRICAL, MECHANICAL

OUR COURSES are Thorough and Practical. OUR INSTRUCTORS are Graduates of the Best Technical Schools. OUR ADVISORY BOARD Consists of Experts of World Wide Fame. OUR TERMS are Low and Within Reach of Every Wage Earner.

SPECIAL OFFER TO READERS OF "MARINE ENGINEERING."

33⅓% REDUCTION For the next 30 days we will give 33⅓% reduction **FOR 30 DAYS.**

from our regular tuition fee to all readers of MARINE ENGINEERING.

Write for hand-book of the school containing schedules of courses, names of instructors, pages from instruction papers, etc.

AMERICAN SCHOOL OF CORRESPONDENCE,
156 Tremont Street, BOSTON, MASS.

AN IMPROVED MEGAPHONE.—A seamless megaphone which is collapsible, like the drinking cups used by travelers, is just being put on the market by Crane Bros., Westfield, Mass. When not in use it makes a package the size and shape much like a silk hat case.

ACETYLENE SEARCH-LIGHTS.—Acetylene search-lights, designed with special reference for use on yachts and vessels of any kind, or wharves where a powerful light is wanted, are being put on the market by J. B. Colt & Co., 5 West Twenty-ninth street, New York. These lights are fully illustrated and described elsewhere, and circulars regarding them, giving considerable information, will be sent to all who wish them.

MARINE RAILWAYS.—With the great increase in marine work, the question of an efficient marine railway is an important one, and the value of special experience in this line will be much appreciated. A firm making a specialty of this work is H. I. Crandall & Son, East Boston, Mass. Marine railways designed under the Crandall patents are installed in many parts of the country, and any ship-yards contemplating adding a railway to its facilities would do well to consult this firm. A small-sized railway is well shown in this issue in the advertisement of this company.

MARINE INSTRUCTION.—The American School of Correspondence, 156 Tremont street, Boston, Mass., offers to marine engineers an excellent opportunity to secure a thorough and practical training in steam engineering. The school is conducted under the supervision of experts in steam engineering. Among the instructors and advisors of the school are Dr. Robert Grimshaw, George L. Fowler, Francis H. Boyer, and other authorities in the engineering field. The school makes a specialty of steam, electrical and mechanical engineering, and the instruction along these lines is unusually practical, thorough, and scientific. Write for their handbook.

INJECTORS AND BRONZE CASTINGS.—The Eynon-Evans Manufacturing Company, Philadelphia, Pa., has been kept very busy this spring by the increased demand among the boat-builders for its Eynon-Korting compound injector. Among the many purchasers of this injector are: William Cramp & Sons and Charles Hillman Company, of Philadelphia; the Maryland Steel Company, of Baltimore, Md.; the Delaware River Iron Shipbuilding and Engine Company, of Chester, Pa.; Harlan & Hollingsworth, of Wilmington, Del.; Charles D. Mosher, of New York City; New Bedford Boiler and Machine Company, New Bedford, Mass.; United States Navy-Yard at Port Royal, S. C., and the United States Navy-Yard at League Island, Philadelphia. This company has also been doing a great deal of work in high-grade bronze castings for the disappearing gun carriages for the United States Government, also propeller wheels, bearings, sleeves, etc., in phosphor and manganese bronze.

LUBRICATION OF GAS ENGINE CYLINDERS.—The proper lurication of gas-engine cylinders has been a difficult problem. The problem, however, seems to have been very successfully solved by an official of the Pennsylvania Railroad Company, who writes: "I had a gas engine, and the man that had charge of it allowed the lubricator to run dry and cut the piston, piston rings, and cylinder. The makers of the engine said the cylinder would have to be sent to the shop and bored out and a new piston put in. It was our busy season, and we could not do without water. I had some of Dixon's finely pulverized graphite, and I commenced to feed it into the cylinder through the suction-pipe with the air and gas, with immediate relief. After about two weeks the engine was running smoother and using less gas than ever before. I had this same engine apart last Saturday, and every place that was cut is smooth as glass. This one instance saved us about $75. I have great faith in this graphite, and always keep it on hand."

FLANGE UNIONS.—One of the improved devices being put on the market by the E. M. Dart Manufacturing Company, Providence, R. I., is a flange union which is used without packing. These unions are made of bronze metal, have ball-bearing seats, and will make a tight and durable joint out of alignment.

CORRUGATED TUBE SURFACE CONDENSERS.—The several appliances manufactured by the Taunton Locomotive Manufacturing Company, Taunton, Mass., for marine work include corrugated tube surface condensers. These are made in all sizes from 50 to 10,000 sq. ft. of cooling surface, and are fully illustrated and described in a catalogue issued by the company. A second-hand condenser is offered for sale by this company, as will be seen among Special Notices.

GOOD STEAMING COAL.—The value of Toms Creek coal for bunker purposes is well emphasized in a letter received by the Toms Creek Coal and Coke Company, Norfolk, Va., from the master of the English steamship Blenheim, who says: "I have had experience of nearly all the various brands of steam coal supplied to steamers of the North Atlantic seaboard. I can conscientiously state that your Toms Creek coal is quite equal to the best, both as regards steaming qualities and economy."

ELECTRICAL EQUIPMENT.—The Sprague Electric Co., 20 Broad St., New York, report an immense increase in business, and the large factory on West 34th St. is now running nights as well as days to supply the demand for Interior Conduit and Lundell dynamos and motors. This Conduit is being used on many of the new Government vessels as well as on private yachts, and the capabilities of the Lundell dynamos and motors have long been established. The new auxiliary vessel "Gloucester," formerly J. P. Morgan's beautiful yacht 'Corsair," is fully equipped with Sprague apparatus.

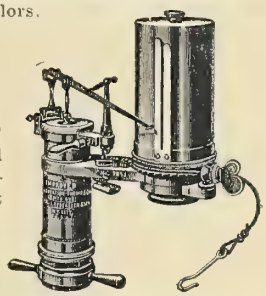
SEND 2 LABELS

cut from front of boxes of EUREKA PACKING and we will send you a pack of beautiful playing cards. All being special in 3 colors.

MARINE ENGINEERS

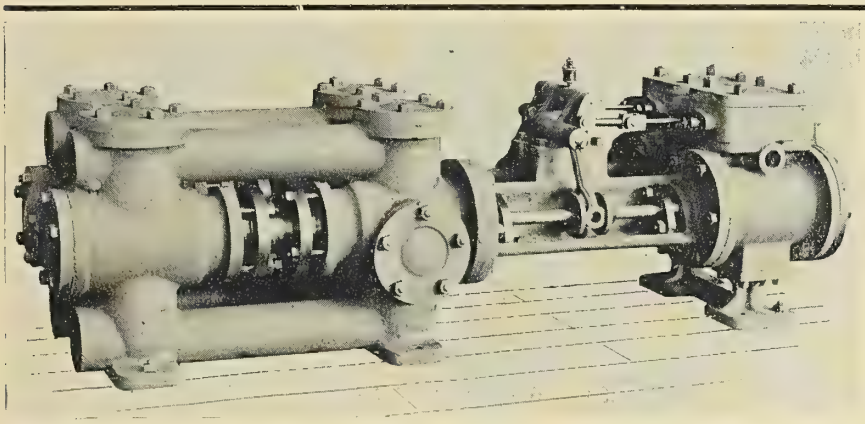
should own an INDICATOR and know how to use it. Send for circular and *special* prices. It will interest you.

Jas. L. Robertson & Son,
218 Fulton St., N. Y.



ANTI-FRICTION METALS.—The great increase in the Volume of marine business has shown a marked difference in the shops of Caskey Bros., Newport News, Va. The demand for Caskey's manganese bronze white packing metal has increased with business, and this company is now supplying large quantities for many of the new vessels built both for private parties and for the Government.

CAPTAIN M. DE PUY, the inventor of the improved leg boiler known as the "Paragon," has decided to build a new Erie Canal steamer, to be fitted with his boiler and a 14 in. by 16 in. low pressure engine. In the canal the boat will carry 160 tons, and in the harbor and sound trade, 250 tons. The hull and engine will be built at Lockport, N. Y., and the boiler by Riter Bros., Buffalo, N. Y. The dimensions of the boiler will be 6 ft. 6 in. wide, 8 ft. long, and it will have 254 2 1-2 in. tubes 6 ft. long.



THE HUGHES IMPROVED DUPLEX PLUNGER PUMPS

Are extra strong, compact and durable. They are externally packed and are particularly well adapted for marine service. Catalogue showing different styles will be sent on application.

THE SNIDER-HUGHES CO., COE AND HAMILTON STREETS, CLEVELAND, O.

The Francis Tool

PATENTED MAY 25TH, 1897.

It has no Screws.
No Slipping.
Made of Wrought Steel.
Cutter Easily Removed.

Write for Prices, etc.

THE UNITED STATES METALLIC PACKING COMPANY,
SOLE AGENTS AND MANUFACTURERS,
429 NORTH 13th STREET, PHILADELPHIA, PA.

A Popular Marine Closet.—The "Neptune" single lever closet recently put on the market by McCambridge & Co., Ltd., 523-527 Cherry St., Philadelphia, has become very popular and is one of the best selling devices manufactured by this company.

Watson Radial Water-Tube Boiler.—This new water tube boiler, which is just being put on the market by Egbert P. Watson, Elizabeth, N. J., is described briefly, but with much force, in the advertisement elsewhere. It is made in sizes from 3-horse power upwards, and is designed for any pressure. Mr. Watson's years of connection with marine matters will be of much value to him in introducing this new invention.

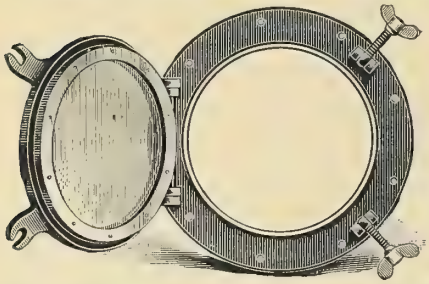
Marine Forgings.—The well-known plant formerly known as the Central Forge Co., at Whitestone Landing, L. I., has been purchased by a new company known as the Whitestone Forge and Construction Co. The plant has been thoroughly overhauled and fitted with the latest improved devices, and is prepared to fill orders for all classes of iron and steel forgings. The New York office of the company is at 11 Broadway, where full information can be secured.

A New Belting.—The question of satisfactory belting is a serious one in shipyards and manufacturing establishments where power is transmitted by this means. In order to satisfy the demand for such belting the Boston Belting Co., 256 Devonshire street, Boston, Mass., is offering its Gutta-Ballata belting. It is seamless and can be run with either side next the pulley, does not deteriorate with age, is not affected by oil or grease, and has many other qualities, set forth in a folder which can be had upon application to the company.

Engineers' Supplies.—We are informed by James L. Robertson & Son, 218 Fulton St., New York, that many of the U. S. war vessels carry a full stock of Eureka packing. This is a compliment which the manufacturers should appreciate. Another specialty of this company which is proving very popular is the Robertson-Thompson indicator, which has many distinct features in its construction and yet is sold at such a low price as to be within the reach of almost any engineer. Full information regarding either of these specialties can be had by applying to the manufacturers.

Electric Power.—The Bullock Electric Mfg. Co., Cincinnati, Ohio, has lately issued a small card which is enclosed in all letters. On one side is displayed a cut of one of the company's motors operating a 72-in. planer. The shaft of the motor is coupled direct to the main driving shaft of the planer. The motor is of small size and is placed on top of the planer, allowing a traveling crane to pass over it. The motor is shunt wound to give constant speed under varying loads, and has a capacity of 12 horse power. On the other side of the card is a short description of the arrangement of motors on machine tools and advantages to be derived from this mode of supplying power. The card is printed in two colors and makes a neat enclosure.

VESSEL MACHINERY AND SUPPLIES.



Windlasses, Captans, Pumps, Steering Apparatus.

Marine Monitor Side Lights.

Contractors' Supplies.

Shipbuilders' Supplies.

Oakum, Caulking Cotton, Deck Plugs, Pitch, Tar.

General Line of Ship Chandlery, Marine Hardware, Cordage, Wire Rope, Yacht Supplies, Flags, Signals, etc.

Marine Manufacturing & Supply Co., 158 South St., New York.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

A KLONDYKE MINE RIGHT HERE.

It is in the new patent Paragon Marine Boiler, illustrated and advertised elsewhere. Half interest or State rights for sale. Address Capt. M. De Puy, 49 South St., New York.

SURFACE CONDENSER FOR SALE.

A surface condenser with 1,816 sq. ft. of cooling surface nearly new, for sale cheap. For full particulars write to the Taunton Locomotive Manufacturing Company, Taunton, Mass.

EXPERIENCED ENGINEER DESIRES POSITION.

Marine engineer, 16 years' experience in shop and drawing room, desires position; has handled men. Address W., care Marine Engineering.

A 75 FOOT STEAM YACHT FOR SALE.

A fine steam yacht 75 ft. long, 12 ft. 6 in. beam, equipped with Wells quadruple engines and water-tube boilers, surface condensers, circulating pumps, speed 18 miles an hour, is offered for sale. Is in prime condition in every respect and has carrying capacity of 75 passengers. For particulars address Steam Yacht, care Marine Engineering.

ENGINEER WITH CHIEF'S LICENSE SEEKS POSITION.

Engineer with chief's license for ocean going steamers (English extra first-class B. of T. certificate) desires position ashore or afloat. Good mathematician and draughtsman and able to investigate all questions relating to economy and efficiency in heat engines. Address "Rex," 2028 East Huntingdon st., Philadelphia, Pa.

PROFESSIONAL CARD.

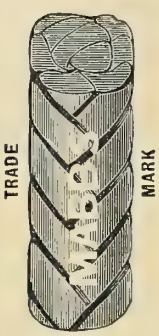
H. B. ROELKER,

Consulting and Constructing Engineer.

Manufacturer of **Screw Propellers** for Usual and for Special Work.

The Allen Dense Air Ice Machine for Steam Vessels.

41 Maiden Lane, New York.



The Mabbs Hydraulic Packing.

USED ON FASTEST ATLANTIC LINERS.

This packing has no equal for Propellers, Stern Pipes, Water Works, Deep Mine Pumps, Ice Machines and all machinery using cold water.

It is the most pliable and durable Hydraulic Packing in the market. *It can be worn entirely out, simply by adding new packing when required, and not disturbing the old.* It will never cut a rod or cylinder, on account of the nature of the material, it being always a good lubricant in itself.

MABBS HYDRAULIC PACKING COMPANY,

BOX 829, CHICAGO.

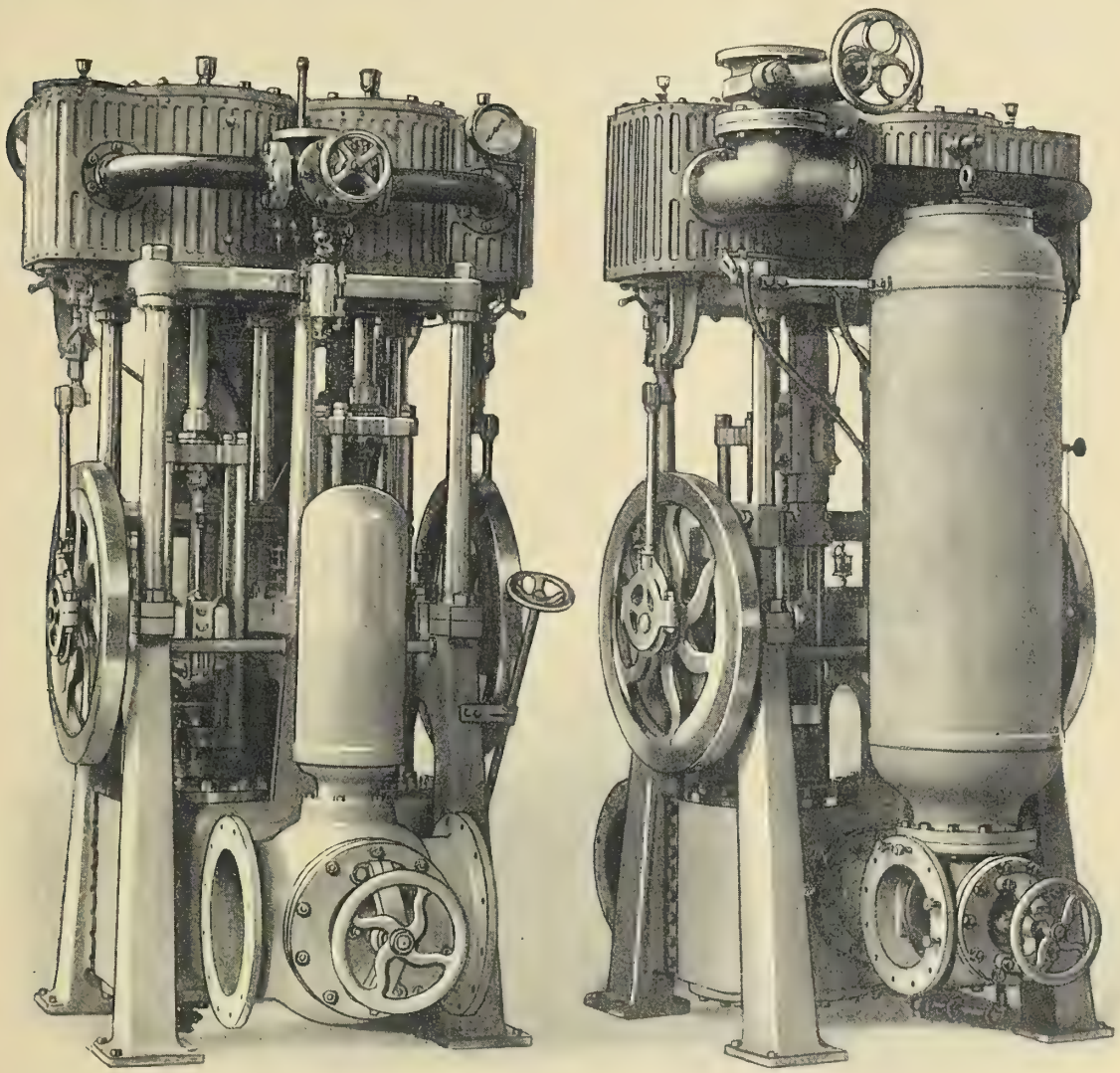
Telegraphic Address: Mabbs, Board of Trade Bldg.

MARINE ENGINEERING.

Vol. 2. NEW YORK, JULY, 1898. No. 7.

FIRE BOAT ROBERT A. VAN WYCK FOR THE CITY OF NEW YORK.

The City of New York has recently added to its fleet of fire boats a new vessel called the "Robert A. Van Wyck." This boat was built from designs made by H. de B. Parsons, a consulting engineer of 22 William street, New York, and the contract was awarded to John H. Dialogue & Son, of Camden, N. J. This contract included the boat complete with the exception of the fire pumps, which were furnished by the department, and were made by the American Fire Engine Company, of Seneca Falls, N. Y., in accordance with specifications drawn by Mr. Parsons.



DUPLEX CRANK AND FLY WHEEL FIRE PUMPS FOR FIRE BOAT ROBERT A. VAN WYCK.

The boat is 110 ft. 6 in. over all; 102 ft. on water line; 24 ft. beam, and draws 9 ft. of water.

Copyright, 1898, by Marine Publishing Co., New York.

The block co-efficient is 0.539; the prismatic co-efficient 0.658, and the displacement tonnage is 306.8. As will be seen from these figures, the lines of the vessel are very full, which was necessitated by the great weight to be carried under the restrictions of length and draught.

Steel was used entirely throughout the construction; and full sea-going weights were adopted for all parts, although the boat is restricted for harbor use. This was done for the purpose of giving additional strength in order to withstand the hard usage of the service, which requires the boat to be continually running in and out among slips and docks. Practically the only wood used was in the construction of the decks, and these decks are protected by a sprinkling system.

The general scheme of design can be seen in the section published herewith: There is a steel deck house, the forward end of which is elevated for the purpose of giving the pilot an extended view in all directions. At the after end the deck house is lowered in the form of a trunk cabin, in order that fire streams may be thrown across the boat in case of emergency.

With the exception of the windows in the pilot house, all openings are made with large port holes, most of them being 18 in. dia. The object of this was to protect the boat in case of a misdirected fire stream from some other boat or tug.

The pilot house is finished in cherry, and contains both the hand and steam steering wheels, which are so arranged as to permit the pilot to change from one system to the other within a few seconds. The two steering systems are controlled by means of a friction clutch which is operated by a hand wheel in the floor of the pilot house. Directly beneath the pilot house is a Manton steam steering engine, and so arranged as to be accessible at all times for inspection or cleaning. The pilot house is equipped with the telephone and fire-gong signaling system, connected to the shore end by means of a flexible cable which can be quickly connected or disconnected.

Abaft the pilot house and connecting with it is the captain's cabin. This room is made large, and is intended to be used as the office of the fire station, and contains a desk and berth. Abaft of the cabin is the fire room hatch. Abaft of the hatch is a store room for the play pipes and nozzles, all of which have their proper places upon shelves so arranged as to make them convenient for the men when the boat is called for fire duty.

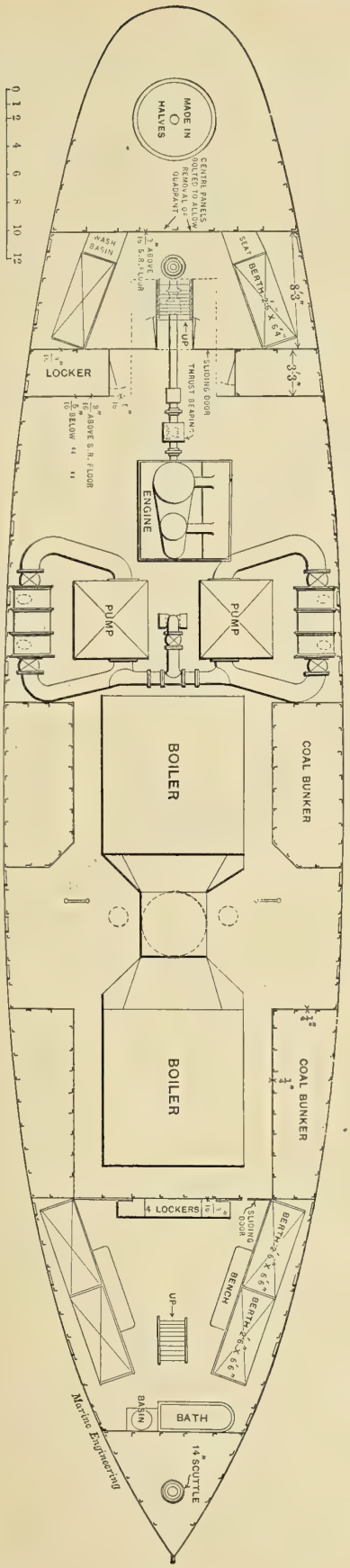
The after end of the deck house contains a large living room for the crew, fitted up with berths and sofas, and a folding table. This room overlooks the engine room hatch, so that the captain could be stationed in this room, and while having a complete view of the operation of the boat could still be close to the engineers for the prompt transmission of orders. The forecastle is fitted up as additional sleeping quarters for the crew, and contains a bath tub, wash basins and other conveniences. At the after end of the boat there are two state rooms which will be probably used by the engineers, as they open into the engine room. With the exception of these state rooms and the forecastle, the rest of the boat is utilized for the machinery.

Steam is furnished by two Scotch boilers each 10 ft. 1 3-8 in. dia. and 11 ft. 0 1-2 in. long, fitted with two Morison suspension furnaces. They are designed for a working pressure of 135 lbs. Each boiler has 132 3 in. tubes and contains 77 sq. ft. grate surface and 2,100 sq. ft. of heating surface.

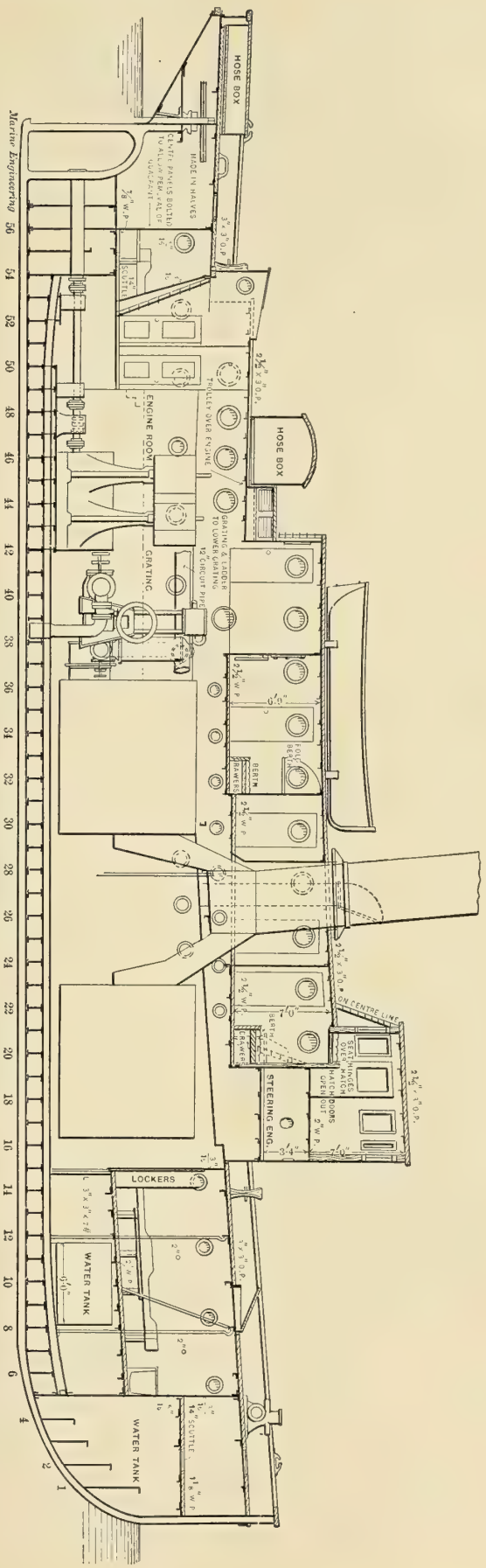
The fire room is purposely made very large, in order that it may be as cool as possible during the summer months, and receives light through the engine room hatch above and through three port lights on each side. On each side of the boilers are the coal bunkers, which are designed to carry from 25 to 30 tons of coal. The bunker bulkheads are set away from the boilers, so as to leave a passage on either side, and, in fact, there is no part of the boilers which cannot be reached with convenience and ease.

The boat is propelled by a fore and aft compound engine having cylinders 16 in. and 30 in. dia. by 22 in. stroke. The high pressure cylinder is furnished with a piston valve, and the lower pressure with a double-ported slide valve. The piston rods are extended so as to form tail rods, and all the glands of both piston rods and valve rods are packed with metallic packing. The propeller is 7 ft. dia. and has an average pitch of 10.59 ft. The rudder was made very large, and in consequence the boat responds very quickly to the helm.

The fire pumps are arranged across the boat athwartships, and are placed between the after boiler and the main engine. Each pump is of the general standard type as built by the American Fire Engine Company, and are of the duplex, crank and fly-wheel type. The steam cylinders are 17 in. dia., the water cylinders 10 in., and the common stroke is 11 in. The suction mains are 16 in. dia., and are connected to large suction bays on each side of the vessel. The area through the strainers, as well as through the valves, is made purposely large, and in consequence the pumps run extremely quiet. The piping is so arranged that each pump can draw from either side at will, or the pumps may be used to pump out the bilge in case of accident to the vessel. The discharge from the fire pumps lead into a large copper circuit pipe which extends all around the deck house; and at the forward and after end are placed twelve hose connection valves, which range from 3 1-2 in. dia. to 6 in. dia., and all are equipped with the New York standard thread. Besides the hose connections there are three monitor nozzles—one large one on the forward deck, one on the top of the pilot house, and one on the after trunk deck.



LOWER DECK PLAN.



INBOARD ELEVATION.

PLANS OF THE FIRE BOAT ROBERT A. VAN WYCK, BUILT FOR THE CITY OF NEW YORK BY JOHN H. DIALOGUE & SON, CAMDEN, N. J.

This arrangement will permit streams from these nozzles to be operated no matter in what position the boat may be placed.

The trial trip was made in the Delaware river, and the boat ran from the yard of the builders at Camden as far as Wilmington and back, and the average speed for the run was nearly 13 miles per hour. The fire pumps on trial discharged over 3,400 gallons per minute each, while working against a water pressure of about 180 pounds; probably the finest set of pumps ever furnished to a fire boat.

In working up the design every care was taken in order to make the boat simple, serviceable and readily handled in cases of emergency. The general arrangement is such that one man can easily operate the main engine and both fire pumps, all the necessary valves and levers being placed near together and close to the engineer's position on the starting platform.

MARINE ENGINE REPAIRS DISCUSSED IN A THOROUGHLY PRACTICAL WAY.*

BY J. KYLES, M.E.

In introducing his subject, the author spoke of the tendency to do work hastily nowadays, which made it specially necessary that a strict watch be kept to exclude unsound material or bad workmanship. The effort of engineers should be to produce lasting work.

Repairs to Cylinders.

Cylinders occasionally require boring out. A good job can be made in their place with a boring bar; this is a somewhat expensive tool to make, and should be as stout as is practicable. There should be about 1 in. of space between the sliding block and the cylinder, and to obtain the truest result have the bar revolving in a journal attached to a strong bracket well bolted across the mouth of the cylinder, the other end in the neck bush resting on a steel center which can be bolted on the stuffing box studs. It sometimes happens that a boring bar will chatter when the tools commence to cut, chiefly owing either to bad fitting journals or the cutters not being properly ground. Every cutter ought to have an equal share of work to perform, and I should say, to make a good job, the boring bar should not be allowed to stop while the finishing cut is being taken. The cylinder having been bored, what is to be done with the piston, which is now too small? Some would say, have a new one. But a new one is not necessary, as by shrinking on a good iron or mild steel hoop 5-8 in. thick with 1-8 in. V groove to prevent its coming off; this hooped piston ought to be turned 1-32 in. smaller than a cast iron one; this method of repairing a piston has been found to work very well. I do not intend going into the many designs of packing rings in use; but the ones that are in greatest demand at present are the "Ramsbottom," which consists of a floating ring in halves with three spring rings. The larger the cylinder the greater natural spring must be given them, also the usual overlap to prevent steam from passing, "cod" pieces not being required. To make these spring rings round, they should be finished in the lathe after being cut, thus insuring a perfect fit in the cylinder. Often cylinder liners have to be renewed, owing to softness of the metal or other causes. These should be cast with about 8 in. of metal head to allow for any bad or dirty metal, thus insuring a much sounder casting. There are different methods of fixing cylinder liners; one is to have a flange on the bottom of the liner and have the same scraped up as valve faces used to be, viz., perfectly steam tight, then bolted to the bottom of the cylinder, and the top of the liner caulked either with copper or lead to make it steam tight. Another is to have the liner turned a tight fit to the cylinder and screwed tight down with bolts into its place.

Crank Shaft Construction.

The new system of securing built cranks by bolting the web to the shaft does not seem to be so secure as by shrinking the webs on. I have seen them in the repairing shop having the holes reamed out and a new set of bolts fitted. This shaft has a great tendency to get out of truth when the bolts become loose; in one case 3-32 in. had to be turned off the shaft to get it true. There is another style of built cranks, the webs of which often get loose, viz., those with collars and eccentric ends. These cranks look very neat when completed, but they do not last so long as those where the part that is shrunk into the web is the same size as the crank pin. When the pin of a built crank shaft is broken the best way to remove it is to build a mould around the web and pour hot metal into the mould; at the same time be ready with an "hydraulic" jack to press it out, as soon as the web is sufficiently expanded. Heavy crank pins require great pressure to start them; it took 160 tons' pressure to start the steamship Belgic's crank pin. It is not a difficult matter to shrink on webs and pins in a new crank shaft, as the journals are all turned up true in the lathe after it has been put together, but in putting a new crank pin into an old shaft great care is required, so that both journals may run true. A good method is to bolt the coupling end of the shaft on the face plate, of a large lathe, keeping the "eye" that is to be shrunk perfectly level; strap the pin, which is now finished, on to the carriage of the lathe, keeping it level and square with the web; make a gauge from the center of the shaft to the crank pin eye. This is to ascertain the amount of expansion that takes place in length and height. Now apply the Lucigen light, which is much quicker than either charcoal or wood, and when the eye has expanded sufficiently to receive the pin, run up the carriage and the pin, insert it the required distance and cool gently by water; next proceed to get the other

*From a paper read by J. Kyles, M.E., before the Institute of Engineers and Shipbuilders of Hong Kong.

end of the shaft on the carriage of the lathe, great care being taken to get it true in every respect, always allowing for the change of form the gauge showed when the web was hot, which in the case cited was at full 1-16 in.; then apply the lamp as before, and in about two hours you can run the other part of the shaft into place, taking care to ease all bolts to allow for contraction, which will now, of course, take place on the web last heated. When the crank is cold it will be found to be true and ready for bedding in place. When a spare shaft has to be put in, the coupling bolt holes are generally found 1-4 in. small to allow for cleaning up and fitting. It will be found to be much the quicker way to take it to a machine (if handy) and get the holes bored out than doing the same with manual labor on board. Coupling bolts are made by some engine builders parallel and by others taper, with and without heads; those without heads should be made with much more taper than those having heads. Sometimes the taper bolts become loose, owing to their having, in some cases, 1-4 in. to the foot taper; this, I consider, is far too little. Where there is no head on the bolt, 1-2 in. to the foot should be given; the parallel bolt with head is easy to fit, but when they require to be renewed after running a few years, the thread, and often the ends, get completely spoiled in taking them out; this means new ends, and frequently they require to be drilled out.

Main Bearing Brasses.

Why do so many main bearing brasses require lining up on the sides? Is it because they have been badly fitted? Possibly so, but the principal reason is they are machined on the sides and fitted in their places and then bored out, and when taken adrift are found to be rather easy, and in a few years the constant strain on the shaft necessitates a liner being put on. A heavy main bearing brass ought to have the skin broken all over before being fitted, as an alteration of form takes place owing to its tension.

Piston Rods.

In many piston rods too little shoulder is left where the piston butts on the rod; the result is that when the rods require turning up there is no shoulder left for the piston to rest on, and the result is a new end must be welded on the rod, or the present small shoulder left on, which means the gland and neck bushes in halves. To prevent scouring the rod, the bushes must be cut at an angle or checked. Some engine builders make their rods of hard steel to withstand wear and tear, but when a new end is required on these rods they cannot be welded with certainty; this often means a new rod, and becomes a very expensive repair, unless the new process of welding hard steel becomes successful. This is now under trial.

Valve Faces.

Valve faces often require renewing, and the time one is often expected to finish this important piece of work in is often insufficient to insure good and sound workmanship. After the valve face has been moulded, it must be thoroughly dried in the stove. Certainly a valve face can be moulded and cast the same day in green sand, but it cannot be depended on. A good plan is to cast the valve face solid and cut the ports out with the machine; this ensures a sound casting with no risk of flaws or cracks, which often occur when contraction takes place, done in the ordinary way. In machining valve faces a finishing cut should always be taken after the ports are cut out, so as to insure a dead true surface. Should valves at any time require piecing on either steam or exhaust edges, and brass is used, which is often done, a bare 1-32 in. should be allowed below the face for difference of expansion of the metals.

Piston Valves

There is a great diversity of opinion as to the merits of the solid or adjustable piston valves. For my own part, I consider that the solid piston valve with three water grooves works very well for the smaller class of engines, say up to 12 in. valves, but in the larger engines, where it is possible to get at the adjustments of same, it is very convenient to have them split. Experience has demonstrated that cast iron piston rings will wear smoother and better surrounded by steam than any other metal. Many engine builders overlook the fact that sufficient clearance is not left in the valve chambers at the piston stroke, the result being that after working for some time ridges occur and have to be removed by chipping or otherwise, which in confined places becomes difficult and expensive.

Eccentric Straps.

We often find in the workshop that the top eccentric strap liner requires to be renewed, while the under liner is very little worn. Now, if both top and bottom straps were made alike, to suit the foot of the eccentric rods, the bottom could be brought to the top, and vice versa, thereby getting double the life out of them. Should white metal be introduced instead of the brass liner, the eccentric sheaves should at all times be turned true and smooth, for unless white metal has a true and smooth surface to run on at the beginning, it will not give satisfactory results. This rule applies to all moving parts of the engine where white metal is used. Metallic packing is also at times applied to piston rods and valve spindles after they have been cut up with other packing, under the impression that the rods will again become smooth. This is a great mistake; no patent packing will give satisfactory results unless the rod is working true and smooth.

Feed and Bilge Pump Plungers.

These often give way at the stems, especially those with cotters through them. A screwed stem is much preferable to one with a cotter, but care should be taken to have a radius at the neck to insure strength. A good method of securing the stem is to carry it the whole length of the

plunger, and have it screwed in the bottom of the plunger with a jam nut outside. I have seen plungers, after being turned up and the glands rebushed, get very badly scored in a very short time, owing to their being carelessly packed with common packing, and the same being screwed up much too tight. A little thought and attention to these details would insure a longer life to many pump plungers. Cast iron bilge pump valve chests are often so badly fitted that a new brass seat as originally made is impossible, there being no bearing to keep it in its place. When such is the case, the only plan is to renew it, to make a proper job. Occasionally time will not permit of a new one being made; then the quickest way out of this difficulty is to have the suction and delivery seat cast in brass, all in one piece, with ports cut out at the sides. This seat can be held in its place by the cover resting on the top of the seat.

Miter, Fiber and Check Valves.

Miter Valves should be a thing of the past, as they are always making the seats larger and cannot be kept tight for any length of time. Flat valves and seats are much easier scraped up and will keep tight much longer. A great amount of labor is caused in breaking joints and removing valve chests and sending them to the engine shops to be refaced.

Fiber valves have a great tendency to become oval when doing their work in the air pump, thus robbing them of their efficiency. To overcome this trouble, a good way is to put them in hot water for two or three days, and then put them in the lathe and turn them while hot, and although they may alter a little when dry, they will become quite flat and true when doing their work in the air pump.

Check valves should always be made of the best gun metal, as anything going wrong with this important chest means detention, and serious consequences may follow.

Crank Pins and Brasses.

Crank pin brasses often require remetaling with white metal. When made of brass they should always have the recess for receiving the white metal thoroughly tinned, so that the metal will adhere to the back of the bushes, and not altogether depend on the dovetailing. Crank pin brasses often become cracked fore and aft. I have known them to run a long time, and very well, with a mild steel liner pinned on the back. Some advocate burning them together, but my experience does not induce me to advocate burning anything that has much work to do. A steamer on this coast went over a bed of sand, with the result that sand was drawn through the condenser, filling up all the tubes; the consequence was the pump levers were bent, circulating pump chest broken, etc., which caused a very heavy repairing bill. Steamers that trade anywhere in the vicinity of "sand banks" would do well, I think, to have top and bottom injection valves fitted. I know of a case where this was fitted, and in going into harbor the ship touched the bottom, thereby stopping up the "rose plate" of the bottom injection. The engineers soon discovered that no water was passing through the condenser. The top injection was now opened, when the engines at once got away all right, showing the utility of the two injection valves. At Tientsin and Shanghai steamers are fitted so. All pins fitted into double jaws ought to be stepped. Often they have to be renewed because they are parallel, the wear taking place in the center where the motion is, which reduces the diameter; but in stepped pins, even although the working part requires turning up, it can be done without interfering with the fitted part. This overlook is also seen in other parts of the engine when repairing same; for instance, some of our coast steamers have worm wheels fitted on their reversing gears, the bore being the same size as the journal and screw. To repair these, an iron liner in two halves must be pinned on the shaft and the worm wheels bored out (larger) to suit.

Copper Piping.

A very important matter in marine engine work is the repairing of copper steam pipes. In small pipes from 4 in. dia. down to 1 in. the coppersmith has little trouble. His principal care is to see that all bends are perfectly round and corresponding in bore to the straight part of the pipe. Resin is mostly used for filling copper pipes which require bending. The great drawback to resin in this climate is the difficulty to get it sufficiently cold, when inside the pipe, to insure good bending; thus, if a copper pipe filled with resin is not thoroughly cold it is impossible to make a good bend. But allowing that a copper pipe has been previously softened by making hot in a coke fire and cooled by the atmosphere gradually, then filled with resin and kept under water all night, in the morning you will find the resin crisp and strong. When the coppersmith bends the pipe you can hear the resin cracking, similar to the noise made when you break a stick. If a job is urgent, lead is resorted to. The copper pipe is first softened, then filled with molten lead and bent. The only good quality lead has for pipe bending is that you can cool it so much quicker than resin. A pipe that would take nine hours to cool with resin can be cool with lead in one hour and ready for bending. If time was no consideration, lead would never be resorted to, because there are so many accidents incidental to the use of lead. For instance, we take a copper pipe 3 in. dia. which has been filled with lead and bent; you will find the bent part of the pipe smaller in bore to the other parts, showing that the lead has got smaller or drawn out when the pipe was bent. Another danger is the propensity lead has to corrode copper when both metals are in contact in a heated state. Great care has to be exercised in melting the lead out of the pipes; the heat has to be regularly

applied along the pipe. If, through carelessness, the pipe gets red hot and melted lead left lying on the hot inner surface of the pipe, it will corrode the copper, and if continued any length of time it will burn a hole through the pipe. This is the frequent cause of pipes having holes through them. Often copper pipes are found strong throughout, but one part very thin, which possibly has been caused through the action of the lead on the hot copper when the pipe was being made. Now, with resin we have none of those accidents. It can be formed in a liquid much easier than lead. Resin expands in bending, keeping the copper the full size at the bends. If time would allow it, all copper pipes should be filled with resin for bending. Solid drawn copper pipes may have many flaws not noticeable to the naked eye. Often the hydraulic test reveals weaknesses and flaws which otherwise we would be unable to determine until the steam was put on the pipes. With brazed pipes it is quite different. They are made by hand, and are cut from the flat sheet of copper, and any flaw can be detected before the coppersmith has rollled the pipe together preparatory to brazing the seam. The seams of all copper pipes should be the strongest part of the pipe if they have the proper overlap and the brazing well done; but, by insufficiency of lap or scarcity of solder, the seams often show signs of weakness. Then pipes are not to be depended on, and the first part to give trouble would be the defective seam. The spigot flange is much the stronger and more serviceable flange, and in brazing flanges a gradual heat is required, being greatest at the fluxing point. To insure a strong brazed flange it is necessary to have the flange and pipe at the same temperature, so that when the solder melts it has an equal attraction from all sides. Some engineers think by giving an order for a spigot 6 in. long they are getting a stronger job. They are mistaken. The brazing only makes a thorough strong job for 2 in. of length, and is stronger than the pipe itself. Copper tee pieces are best made from sheet copper, and the flange part carefully worked over hot and cold alternately. The inside copper tee piece is the strongest; this tee piece is brazed from the inside, making a strong joint between pipe and tee piece. With saddle tee pieces often only the edges are brazed. This makes a weak job. Of course, there are pipes on which, from the construction of their bends, it would be impossible to braze an inside tee piece, but wherever practicable a tee piece brazed on the inside is much stronger than one brazed on the outside.

On Propellers and Shafting.

Should the bore of propellers on the large end be found pitted, either by being neglected or by lying in the hold as spare gear, or to have been badly fitted on the shaft originally (many establishments are far too careless in the fitting of this important item), a good job can be made of it by boring out the pitted part of the propeller and carefully fitting in a steel liner, say 3-8 in. thick, having a recess bored out for a collar, which must be large enough so that the key seat will not cut it through, and pinning the liner with countersink pins. Should it be the small end of the propeller boss, leave a shoulder for the liner to rest on, which will take the strain off the pins when the propeller is being driven on the shaft and being fitted. Cast iron and steel propellers are all liable to extensive pitting on the back of the blades. Tin has been tried as a remedy for this, also many other devices, but the best I have seen for preventing this pitting and the wasting away of the blades in this particular spot is the fitting on of a brass liner, say 3-16 in. thick on the blade tips, riveted to a narrow strip of brass, say 4 in. broad on the go-ahead side, which fastens the edge of the brass liner, the remainder being secured to blades by stud rivets. This I have always found to give satisfaction. All right-handed propellers should have left-handed screws on the shaft. By doing this the nut would have a tendency to tighten itself on the propeller, and vice versa for a left-hand propeller. Should the brass liner on the shaft get loose, I may mention three methods of putting it on, viz., by hydraulic pressure, shrinking and casting. Few establishments make use of the hydraulic plan, owing to the varied lengths of shafting. The casting on of the liners is not much in vogue, owing to the tendency of the heated shaft to bend. The most popular method of putting on liners is by shrinking them on, proper allowance being made for tightening on the shaft; and, if properly done, there is not much fear of their coming loose, pins being used to assist in securing them. I have seen a liner quite tight to the two ends and condemned for being loose in the center, caused, I should say, by being allowed to become hot. In forging a new end on a propeller shaft in the furnace the first process is to cut off the bad end of the shaft, stave up the end to allow for deterioration by the heat, then procced to lay on the shingled iron which is made from scrap, working it under the steam hammer until the proper size and length is attained. In this way the shaft is equally as good as new. Large piston rods ought to be dealt with in the same manner when a new end is wanted. The fracture of propeller shafts very often occurs at the ends of the brass liners, either at the propeller or inside the tube, the reason for which is on account of the galvanic action set up between the brass liner and the shaft. A very easy way to break a bar of iron is to nick it all around and give it a sudden blow; and this is what takes place at the ends of the brass liner on propeller shafts, as the line of corrosion forms a ring around the shaft. One would hardly credit the depth this corrosion goes to. To render the galvanic action at the end of the liner less, a good way is to taper the end of the brass liner towards the shaft; but the best preventive is to cover the body of the shaft with tin,

say 5-16 in. thick, between the liners. This is done as follows: The shaft is cleaned up in the lathe and then soldered from end to end to insure the tin adhering to the shaft. A mould is then made around the shaft, which is then made hot and the tin cast around the shaft. It is then turned up in the lathe. This method increases the safety of the propeller shaft by keeping the water from it, and thus preventing galvanic action. The admiralty always cover their propeller shafts with brass liners from end to end, to prevent the water coming in contact with the shaft. In shrinking on those long liners, it is scarcely possible to get a close joint, owing to the shrinkage going in towards the center while cooling. The joint must be caulked, and in many cases is not a satisfactory job, and should water get in through porous metal or bad jointing, the corrosion takes place much quicker than if it was exposed. Many stern bushes have brass strips between each lignum vitæ stave to keep them tight. A good deal of labor is occasioned by this bush, both in casting and fitting in the lignum vitæ. The easiest stern bush to repair is one with two brass strips opposite each other, with the lignum vitæ fitted against them. Care must be taken to have a V cut out between each strip of wood to allow the water to pass into the bearing. Some are of opinion that the lignum vitæ swells when going into the water. I have seen this tested, viz., a stern bush being filled with water stood for six weeks, and when emptied was found by gauge to be precisely the same size, thereby showing that no allowance need be given for the swelling of the wood.

Thrust B'ocks.

The old style of having all solid brass rings in the thrust blocks does not commend itself, as they are very difficult to line up properly when much worn. The best way is to recess the rings in the lathe and fill them up with white metal. The horseshoe rings are most in favor now and are much the easiest to repair. Tinning cast iron is of little use when putting in white metal, as the tinning does not adhere to the cast iron; therefore the white metal has to depend on the dovetailing. In overhauling thrust blocks, some designers entirely overlook the fact that water has often to be used on the thrust, for we often find steel or iron screws and nuts used for squaring up the thrust rings against the face of the collars on the shaft. Corrosion takes place in a few years and makes them impossible to remove, rendering the hammer and chisel necessary to cut them off. Other thrust blocks have steel screws with brass nuts, and are so constructed that it is impossible to use the ordinary spanner to adjust them. There being no room to use a spanner, the consequence is that the hammer is resorted to, burring up the nuts. This is not at all satisfactory. Muntz metal bolts and nuts having a collar, say 1-2 in. thick, would prevent burring, even although pounding with the hammer was resorted to. Those nuts would always bring the shoes to their former position, not allowing them to get twisted, as they sometimes do with common nuts, thereby causing undue wear and a warm thrust.

General Suggestions.

It is not necessary to go over the many minor parts which are constantly passing through the repairing shop, yet, though small and insignificant to appearance, they have to fit into their respective places as accurately as the larger parts, and at times great skill and ingenuity is required in getting the old parts in good order. A lead pattern is preferable to a wood one for intricate work. A perfect mould can be got, and when cast it will be found to require very little fitting. In giving orders for repairs, every item ought to be fully explained and thoroughly understood. Some engineers make drawings of what they want, which is a good idea; word of mouth orders, when passed from one to another, have a tendency to lose some of their specialties. It is not easy to fit work properly, when the steamer is lying a few miles away, with gauges, unless it is understood what travel the gauge has to have in the fitting part. If engineers would give the amount of travel in inches their gauge requires it would often save a great deal of filing on board. A repairing shop ought to be in a position to forge and finish any shaft that may break in any steamer on the coast; also to make new any part of the engine, from the cylinder downwards. As the working parts of an engine get worn first, viz., piston rods, valve spindles, bushes, valve, etc., a great variety of machines ought to be at command to overcome the turning and machining of these parts in the shortest possible time, so that the charter can be kept good or the day of sailing not interfered with.

Spain's Swiftest Auxiliary Cruisers.

In the engravings many of our readers will recognize the former transatlantic liners, Normannia and Columbia, now the Spanish armed cruisers Rapido and Patriota, having been recently fitted out at Cadiz. These splendid steamers were in service, since they were built about eight years ago, between New York and the continent of Europe, and were very popular indeed with transatlantic voyagers.

The "Rapido," which is slightly the larger of the two, was built in 1890 at the yard of the Fairfield Shipbuilding and Engineering Company at Govan on the Clyde. This is the company which built many of the crack Cunarders, and, indeed, the "Rapido" closely resembles the Cunard liners Umbria and Etruria in many essentials. The latter boats, however, are only fitted with single screws. The "Rapido" is 520 ft. long; 57 ft. 6 in. beam, and 38 ft. deep molded, and at 24 ft. draught displaces 11,500 tons. Her gross tonnage is 8,500 tons. She is fitted with four com-

SPANISH AUXILIARY CRUISER RAPIDO—FORMERLY TRANSATLANTIC LINER NORMANNIA.

SPANISH AUXILIARY CRUISER PATRIOTA—FORMERLY TRANSATLANTIC LINER COLUMBIA.

plete decks and a promenade and was designed to carry in all 1,292 passengers. She has twin screws and triple-expansion engines of the three-cylinder, three-crank type, with cylinders 40 in., 67 in. and 106 in. dia., and 66 in. stroke. A longitudinal bulkhead separates the engine rooms, as in our "St. Louis" and "St. Paul," and the "Rapido" has also eleven transverse bulkheads and is subdivided in all into thirteen watertight compartments. With 160 lbs. boiler pressure and 85 revolutions the engines indicated 16,300 horse power. There are three boiler compartments, each containing three double-ended Scotch boilers, 16 ft. dia. and 18 ft. long. Each boiler contains eight furnaces, making 72 in all. The coal consumption is about 300 tons in twenty-four hours at full speed. The propeller shafts are carried outboard and the propellers are 18 ft. 1 in. dia., and 16 ft. 9 in. pitch. One circumstance connected with this vessel, which caused much comment at the time, was that her keel was laid and her trial trip finished within the space of twelve months. She was designed for a sea speed of 19 knots and on trial exceeded 21 knots, but her average speed in regular service was below rather than above 19 knots.

The "Patriota" was built by the Lairds (builders of the Confederate cruiser Alabama), Birkenhead on the Mersey in 1889. Her dimensions are: Length, 480 ft.; beam, 56 ft.; depth from main deck, 35 ft. 6 in. Her gross tonnage is 7,363 tons and at 24 ft. draught her displacement is 10,000 tons. She is fitted with twin screws driven by triple-expansion engines, with cylinders 41 in., 66 in. and 101 in. dia., and 66 in. stroke. With 150 lbs. boiler pressure, and at 74 revolutions, she develops 13,680 indicated horse power. There are nine Scotch boilers, each 15 ft. 4 in. dia., and 17 ft. 2 in. long, each with six furnaces, making fifty-four in all. The coal consumption is about 280 tons a day. The propellers are 18 ft. dia., and 31 ft. pitch. Though smaller than the "Rapido" and with less horse power proportionally her lines are finer and in actual service she is the faster boat.

Both these vessels were originally designed to conform to specifications for German auxiliary cruisers, and were built to carry eight 5.5 in. and four 4.7 in. rapid fire guns as well as several small rapid fire and machine guns. It was reported, however, that since their purchase by the Spanish government they have been strengthened structually by English engineers and will carry 8-in. rapid fire guns in their main batteries.

The new side wheel steamer City of Erie for the Cleveland and Buffalo Transit Co., built at the yard of the Detroit Dry Dock Co., at Wyandotte, Mich., is ready for service. She is a freight and passenger steamer, 324 ft. long; 76 ft. extreme beam, and 18 ft. deep molded. Her engine is of the compound condensing walking beam type, taking steam from six boilers. She is expected to attain a speed of about 21 miles per hour.

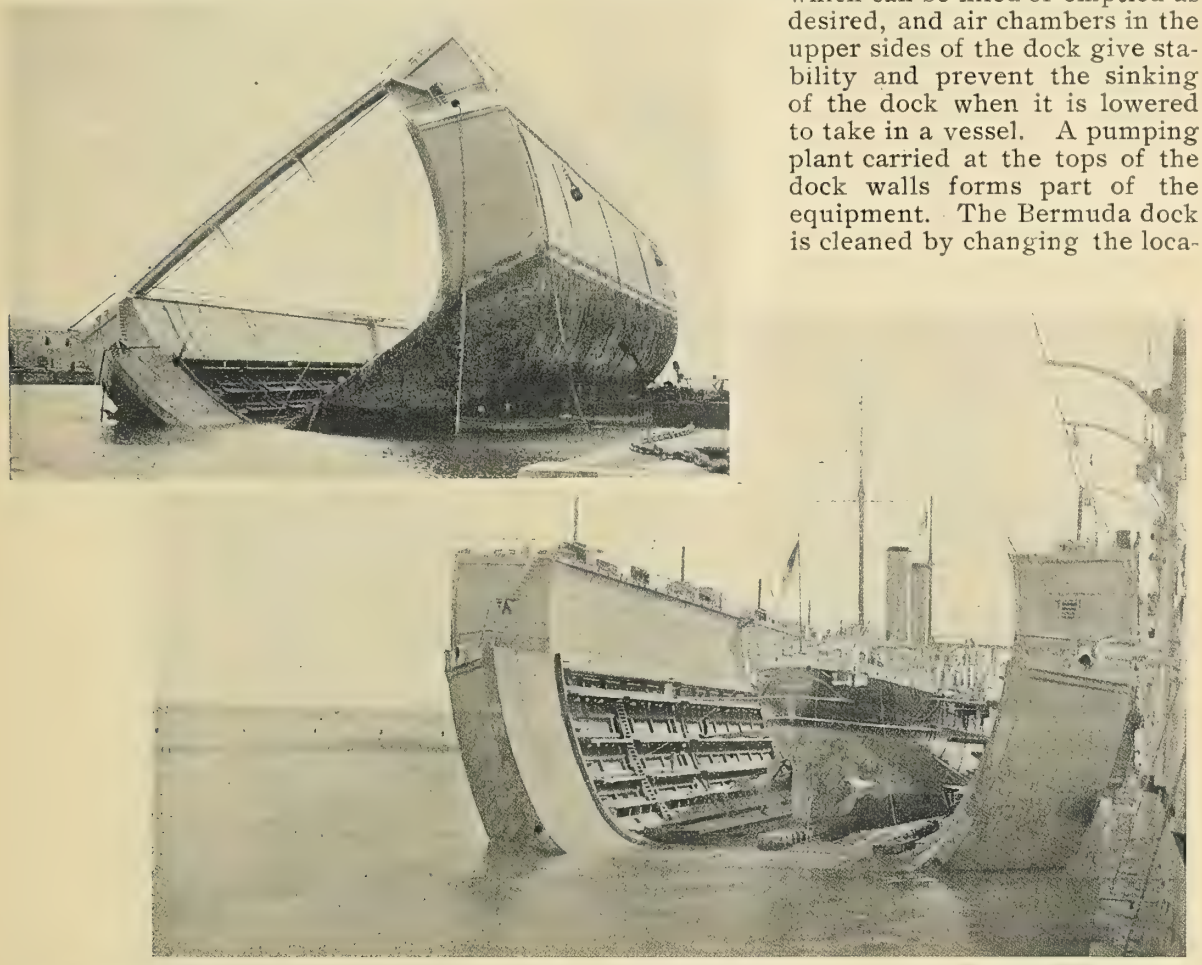
PROPOSED U. S. NAVAL FLOATING DOCK TO BE LOCATED AT NEW ORLEANS.

In the naval appropriation bill Congress recently made an appropriation of $200,000 for the construction of a steel floating and graving dock to be located at the Naval Reservaton at Algiers, Louisiana. Plans for this structure are now being prepared by the Bureau of Yards and Docks under the supervision of Civil Engineer M. T. Endicott, U. S. N. Additional to this amount there is a further appropriation of $650,000 for the necessary expenses of moorings and wharf. This dock will be of great capacity, capable of lifting the heaviest battleship or any vessel up to 15,000 tons displacement and with a draught of 27 ft. of water.

The appropriation has directed present attention to this form of dock. Some critic might consider Congress had been a little premature in providing for this much needed improvement out of American tax-payers pockets. Upon the only possible termination of the present war we shall come into possession of the great floating dock at Havana, which was built not long ago in England and towed out. Spain has always been partial to floating docks, and, indeed, strange as it may now seem, in earlier days she displayed more enterprise in the construction of such docks than any other nation. In home ports she has two large floating docks which, though built more than thirty years ago, should still be in good preservation, unless the proverbial Spanish neglect in engineering matters has made them worthless. A floating dock becomes a necessity in localities where a foundation cannot be made on land except at a prohibitive cost, or where the rock, if such is the coast, is too porous to excavate a safe dry dock.

Floating docks are not by any means a recent invention and it is to American ingenuity that the credit for the development of this form of dock belongs. A hundred years ago floating docks were in use abroad, though these were not entirely independent of land. They were usually sunk between rows of piles, to take on a vessel, so that they would not upset in the process of lifting. In the present century sectional and balance docks were (and are still) extensively used in this country, though invariably built of wood. A wood balance floating dock was built at Pensasola in 1851, which was 350 ft. long, 60 ft. wide on the floor, and had a lifting power of 8,000 tons. About the same time a somewhat larger dock was put into service at Pola, the Austrian naval station. In the modern form, the first iron floating docks of importance were built for the Spanish Government in England by the eminent civil engineer Rennie. This was late in the sixties. These docks were for the naval establishments at Carthagena and Ferrol in Spain. They were of almost similar size, the largest, that for Ferrol, measuring: Length, 350 ft.; beam, 105 ft.; depth inside, 37 ft. 6 in.; breadth inside, 79

ft.; weight complete, 5,000 tons; displacement at base, 13,125 tons. It had a capacity up to 8,000 tons, and with a vessel of about 5,000 tons its draught was about 10 ft. 6 in. At one of these docks, we believe there was an arrangement by which a vessel could be hauled off the dock onto ways on shore, so that more than one vessel could be repaired at one time. About this time, too, a floating dock was built at Cardiff for St. Thomas in the Danish West Indies, a place which has come into prominence during the present naval operations. This dock was 300 ft. long, 72 ft. wide inside and could take in a 4,000 ton vessel of 24 ft. maximum draught.



FLOATING DOCK OWNED BY THE BRITISH GOVERNMENT AND STATIONED AT BERMUDA.

Floating docks of importance were also built during this period in Great Britain for use in East Indian water and at Callao, Peru. These docks were about 300 ft. long. The most notable dock, however, was that constructed on the Thames, for the British Government, to be stationed at Bermuda. This dock is still in active service as will be seen from the accompanying engravings,[1] showing a British war vessel dry docked and also the dock tipped for cleaning.

[1] Reproduced from the Army and Navy, London.

This dock is U shaped, a form which in more recent docks has been replaced by the rectangular form. This latter type is very much like a rectangular box with open ends and without a lid. In the later docks the lower or horizontal portion is made of independent pontoons. These are fastened together by screwed joints, so that any pontoon can be detached and hoisted up or floated on the dock itself, for cleaning and painting. This form of dock also makes possible an increase in dimensions of the structure by the addition of pontoons and the lengthening of the sides. In all these docks the buoyancy or lifting power depends upon the bottom of the dock, which can be filled or emptied as desired, and air chambers in the upper sides of the dock give stability and prevent the sinking of the dock when it is lowered to take in a vessel. A pumping plant carried at the tops of the dock walls forms part of the equipment. The Bermuda dock is cleaned by changing the location of the water ballast so that either side and part of the bottom is exposed. In dimensions this dock measures 380 ft. long; 124 ft. outside width; 84 ft. inside width, and 72 ft. depth over all.

Coming down to recent times the largest dock in the world was built last year at Hamburg by Blohm & Voss. This is 624 ft. long; 118 ft. wide, and has a lifting capacity of 17,500 tons. The pumps of this dock are said to have sufficient capacity to pump it out in forty-five minutes. In its present location at ordinary high tide ves-

sels drawing as much as 26 ft. of water can be docked, though it is capable of lifting vessels of over 29 ft. draught.

German engineers have long made use of floating docks, of which a number are now in use there. A dock of the rectangular form has lately been constructed in England for the Vulcan Works at Stettin, with a capacity of 12,000 tons. This will be first used for the lengthening of two of the single-screw North German Lloyd liners.

The Havana dock also ranks as one of the largest. It is 450 ft. long; 82 ft. in the clear between the altars, and 27 ft. 6 in. deep over the sill. At this immersion the draught is 42 ft. 6 in. and the freeboard 4 ft. 2 in. The pumping plant on this dock is operated by electricity.

Another big dock for the Spanish Government was contracted for early last year, to be located at Olongapo in the Philippine Islands. The contract was let to a Tyneside firm in England, and the intention was to build it in sections and ship these out for erection in position. The dock measurements were: Length, 450 ft.; width over pontoons, 117 ft., and depth, 38 ft. 6 in. It was to be capable of accommodating a vessel 500 ft. long and of 12,000 tons weight. We have no information as to whether or not this dock has been completed. It cannot very well have been delivered and put together in the time which has elapsed since the contract was let, and so probably it will not be useful to Admiral Dewey.

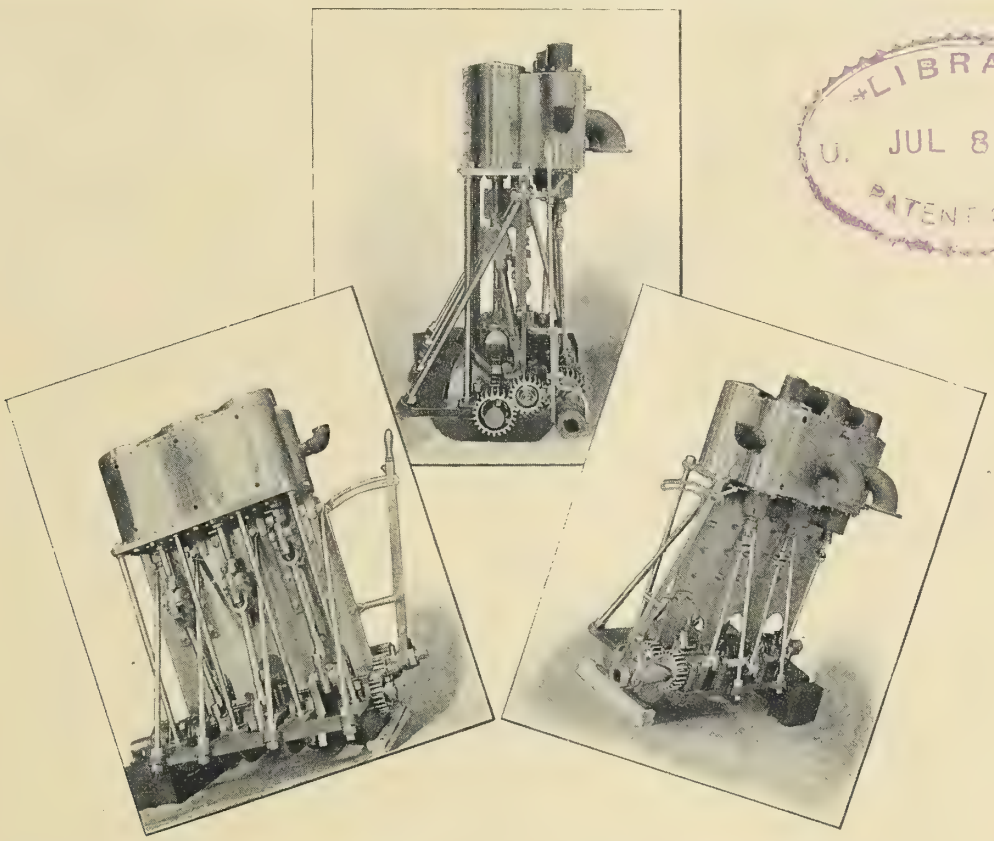
In what might be termed the home of the floating dock its construction has been opposed by persons here who had a voice in the matter. Experience, however, has shown that this type of dock is a very practical one even in the largest sizes. There have been mishaps in the use of these docks just as in all other forms of mechanical constructions. The dock at St. Thomas, here referred to, sunk at its moorings soon after it was put in place and it remained under water for several years, causing the insolvency of its owners. Wreckers finally raised the dock with the aid of compressed air and it was again put to good use. The great dock at Havana also sank not long ago, soon after it was towed across the Atlantic, for reasons not explained. Possibly it had been strained by the long ocean voyage, or more likely the inefficiency of the colonial engineers caused the mishap. No reports as to the present condition of this dock have been noticed.

One advantage which a dock of this form has over those with gates is that if a vessel is too long for the dock proper it is possible to leave the ends projecting, provided, of course, the amount is not so much that the lack of support would strain the vessel. It has also been the practice, frequently, in docking a small vessel in a large dock to float in a pontoon upon which the vessel could be blocked, leaving working space all around, and so avoiding the necessity for pumping the dock entirely out.

COACHING LAUNCH "CORNELL" USED BY THE CORNELL UNIVERSITY ROWING CREW.

COACHING LAUNCH USED BY THE CORNELL UNIVERSITY ROWING CLUB.

is the name of a highly successful and interesting coaching launch shown on page 12, which is used by the celebrated trainer, Courtney, in coaching the Cornell rowing crews on Lake Cayuga. The requirements of a coaching launch differ somewhat from those of a pleasure boat of about the same dimensions. It must have sufficient speed to keep up with or outrun a racing crew, but beyond this rate of speed no increase is necessary. As the highest racing speed of a crew is about 12 miles per hour a speed of 14 1-2 miles was provided for in the design of the "Cornell." Not only has the question of coaching speed to be considered, but the special one of accommodation. The boat must have sufficient size and stability to carry one or more crews, as occasion may demand, and to serve as a landing or embarking stage for crews entering or leaving the shells. In this particular case, too, having in mind the reputation of Lake Cayuga for sudden squalls, the dimensions and form had to be such as would give an entirely seaworthy boat in any weather. There was also a very important little kink in the design, of special interest to propeller sharps, and that is the necessity for having a boat that would gather headway and quickly attain maximum speed. This is a serious defect in many boats of this class. A racing shell with eight muscular men at the oars doesn't lose much time in getting away at the start—racing speed is attained almost instantly. Consequently unless the following launch can attain high speed quickly the distance between the coach and crew will become inconveniently great. In the case of the Cornell launch it is surprising to see how rapidly the launch "jumps" after the shell when the trainer pulls a go-ahead bell. In the construction of such a launch Cornell had a decided advantage over the other universities, in that it had the professional skill of Professor W. F. Durand, principal of the School of Marine Construction of Sibley College, to draw upon.



LIBRARY U. JUL 8 1898 PATENT OFFICE

VIEWS OF THE COMPOUND ENGINE OF THE LAUNCH "CORNELL."

The original launch "Cornell" was constructed in the summer of 1894, and was in use during the spring of 1895. About the close of the practice season the house in which the launch was kept took fire mysteriously and the hull of the "Cornell" was destroyed. The rowing committee decided to build a new launch, and the first was so successful that the present "Cornell" was laid down on practically the same lines, during the summer of 1895. The original machinery was overhauled and with a slight replacement of

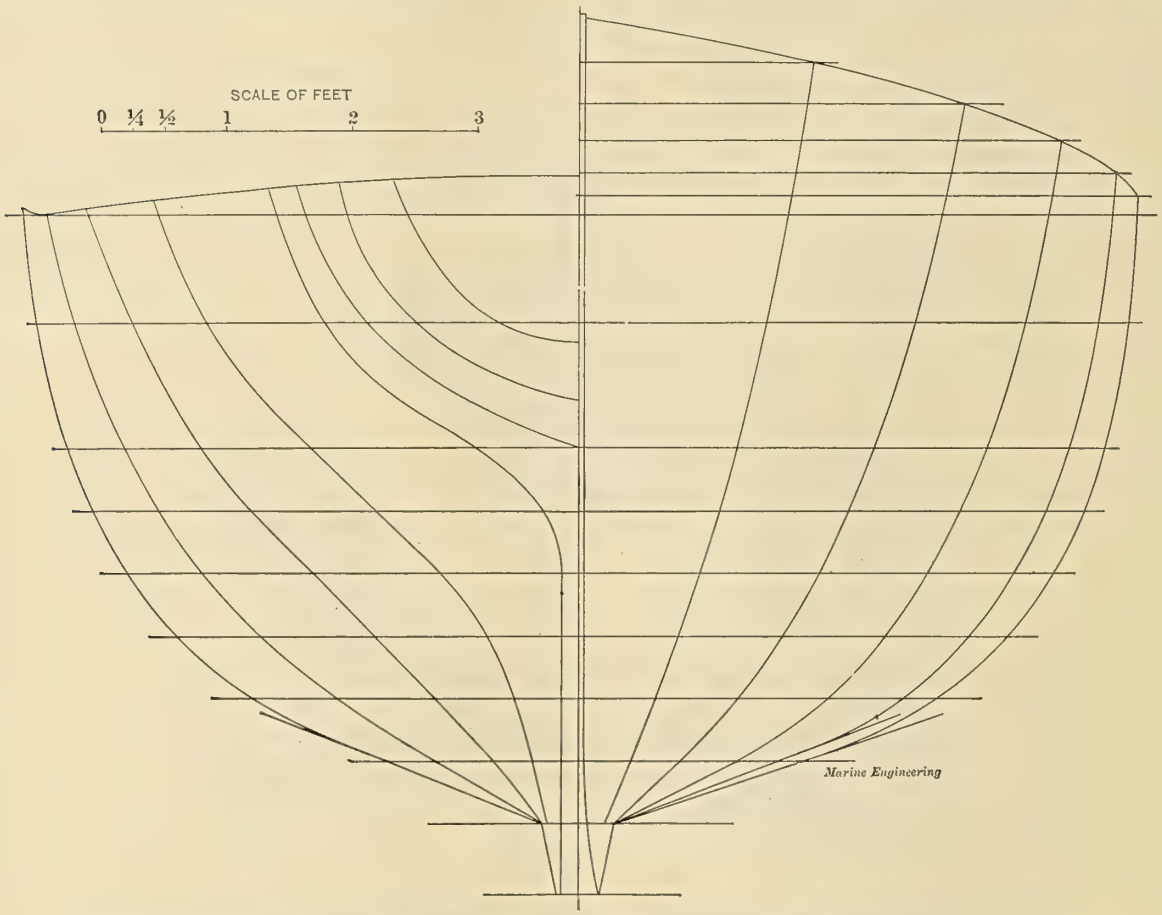
parts was made as good as new. Since that time the launch has been in regular use each spring and has come to be almost affectionately regarded by the Ithaca oarsmen.

The skill of several persons contributed to the general result. Charles Kellogg, of Athens, Pa., was given the contract for the launch. The engine was designed under his supervision and built by Payne & Sons, of Elmira, New York. The boiler was supplied by George Warrington, of Chicago, and is of his water-tube type. The lines of the hull and propeller were designed by Professor W. F. Durand, and the hull was built by B. F. Taber, of Ithaca, New York.

which are formed or bent to the required shape. White oak is also used for the keel which is made of 7 in. by 9 in. timber. The interior is oil finished in oak throughout.

Both engine and boiler are located amidships, dividing the boat into two sections, with, however, sufficient room on either side for passage between them. The cock pit forward is of large size and is intended especially for the use of the coach in directing the operations of the crew, though he may also make use of the after cock pit, or of the decked over ends at the bow or stern as well.

The boiler shown in outline in the cut here-



LINES OF THE COACHING LAUNCH "CORNELL," DESIGNED BY PROFESSOR DURAND.

In detail the principal dimensions and characteristics of the hull are:

Length of water line	56 ft.
Length over all	60 ft.
Maximum beam	9 ft.
Beam at water line	7 ft. 8 in.
Draught including keel	2 ft. 6 in.
Depth of keel	7 in.
Displacement	21,400 lbs. or 9.55 tons
Area of midship section	10.56 sq. ft.
Block co-efficient of fineness	.38
Midship section co-efficient of fineness	.676
Prismatic or cylindrical co-efficient	.562
Water plane co-efficient at L. W. L.	.604
Mean depth co-efficient	.629
Weight of hull	about 12,000 lbs.

The hull is double planked, having two 5-8 in. layers of white pine inside and Georgia pine outside. White oak is used for the frames

with is of compact form. In this type the tubes forming the boiler proper are filled with water throughout their entire length. When running, a very rapid circulation is secured, and any deposits are carried down to the mud drum through the down pipes, which are of large diameter. The steam drum is fitted with a centrifugal separator, and in the water drum a blow-off pipe is fitted, to which is attached a conical funnel for the removal of sediment. The boiler data includes:

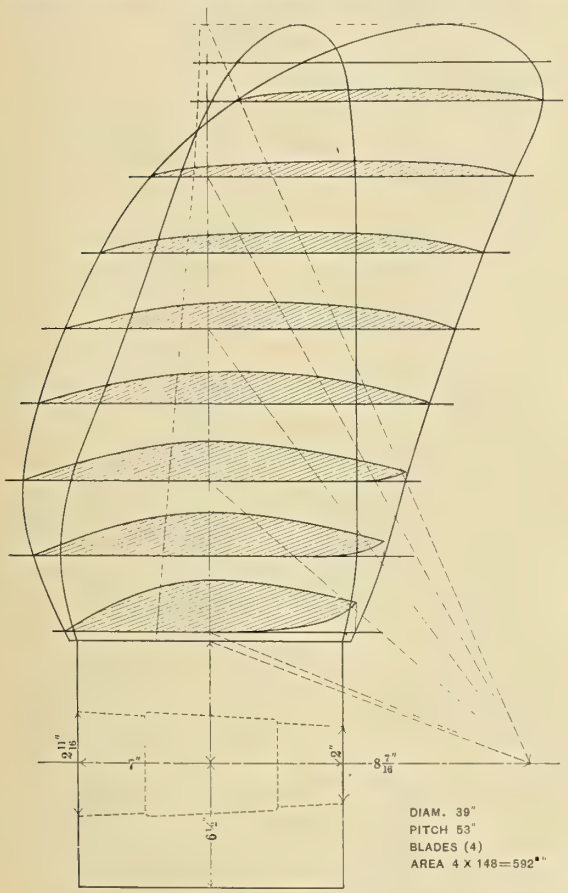
Heating surface	365 sq. ft.
Grate surface	9 sq. ft.
Weight	5,200 lbs.

The engine is of the vertical three-crank three-

cylinder compound type. The two L. P. cranks are opposite at 180 deg. and the moving parts mutually balance. The H. P. crank is at 90 deg. with these and is provided with a crank counterbalance for its moving parts. The combination as a whole gives a well balanced engine, producing but little vibration at any speeds at which it has been run. The chief dimensions and characteristics of the engine are:

Dia. of cylinders	one H.P. 6 in., two L.P. each 8 3-4 in.
Stroke	8 1-2 in.
Ratio of L.P. to H.P area	4.25 to 1
Total number of expansions	about 7
Steam pressure at H.P. cylinder	200 lbs.
I.H.P.	100 at about 375 rev. per. min.
Main steam pipe, dia	2 in.
Exhaust pipe, dia	two 3 1-2 in.
Piston Valve, H.P., dia	2 3-4 in.
Piston valve, L.P., dia	two 4 7-8 in.
Front columns	four steel rods 1 1-16 in. dia.
Rear support	steel plate 5-8 in. thick
Oblique braces add further to the transverse support.	
Pistons, cast steel	3-8 in. thick
Piston rings	two 7-16 in. face
Piston rod, dia	1 1-8 in.
Crosshead pin	2 3-8 in. long by 2 1-8 in. diam.
Slide surface	8 in. by 4 5-8 in.
Connecting rod, length	23 in.
Connecting rod, dia	1 5-16 in. and 1 1-2 in.
Crank pin	3 1-4 in. long by 2 7-8 in. dia.
Crank webs	3 1-2 in. wide by 1 1-2 in. thick
Crank shaft, dia	2 7-8 in.
Thrust surface	33 sq in.
Weight of engine and auxiliaries	4,000 lbs.

The valve chests are placed on the sides of the cylinders and the valves are operated by a valve

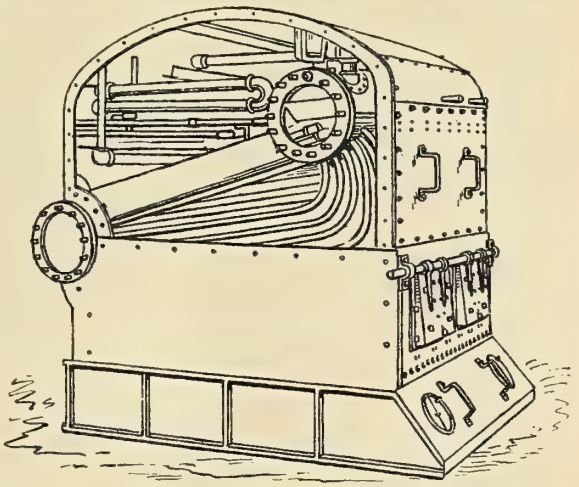


PROPELLER OF LAUNCH "CORNELL"

shaft given motion from the main shaft by means of spur gearing as is common with gears of this type. Phosphor bronze was intended to be used for the propeller, but questions of local convenience caused the substitution of cast iron. The propeller data is:

Diameter	39 in.
Pitch	53 in.
No. of blades	4
Helicoidal area	592 sq. in. or 4.11 sq. ft.

The auxiliaries include a compact Wheeler cylindrical condenser, a combined air and circu-



WATER-TUBE BOILER IN LAUNCH "CORNELL."

lating pump of these dimensions: Steam cylinder, 4 1-2 in. dia. by 6 in. stroke; water and air cylinders, 6 in. dia. and 6 in. stroke, and an independent feed pump and injector.

Steering is effected by a wheel fitted to a bracket on the bulkhead in the forward cockpit from which the tiller ropes are carried aft by the usual guides.

The launch "Cornell" was designed to have a maximum speed of about 14 1-2 miles per hour, or a sustained speed of 14 miles. These requirements have been more than fulfilled, though in a general way the results correspond closely to the expectations of the designer. A speed of 14 1-2 miles is readily obtained with about 90 I. H. P. and 360 revolutions, while a moderate cruising speed of 12 miles may be maintained with about 50 I. H. P. and 280 revolutions.

The battleship Alabama was launched at Cramp's shipyard, in Philadelphia, May 18. This fine vessel is 368 ft. long, 72 ft. 2.5 in. beam, and has a mean draught of 23 ft. 6 in., on a displacement of 11,525 tons. She will be fitted with twin screws, driven by engines of 10,000 I. H. P., with which a moderate speed of 16 knots is expected. She is protected with armor of thickness varying from 17 in. to 2.75 in. In her main battery she will carry four 13-in. breech-loading rifles and fourteen 6-in. rapid-fire guns. Her secondary battery will include sixteen 6-pounder and four 1-pounder rapid-fire guns, and one Colt and two field guns. She will have also four long Whitehead torpedo tubes. Her keel was laid December 1, 1896, and her date of completion is set for September 24, 1899.

CONCERNING THE NEW NORTH GERMAN LLOYD LINER KAISER FRIEDRICH.

When the new North German Lloyd liner Kaiser Friedrich left Southampton for New York June 8, it was confidently expected by many that if she failed to break the fastest passage record she would at least make a new maiden trip record. Her builder, F. Schichau, of Elbing, Prussia, was known to be an expert in the construction of fast steaming vessels, and, besides, he was on his mettle, for his German rival, the Vulcan Company, had exceeded all previous performances with the "Kaiser Wilhelm der Grosse." When record time was reached, and the new liner Kaiser Friedrich had not been sighted, on this side, these expectations gave place to a hope that a fast ordinary trip would be recorded. Another disappointment was in store, however, for not until early on the morning of June 15 did the big liner pass in at Sandy Hook. Her corrected time for the trip then stood at 7 days, 10 hours and 15 minutes. As the course run was 3,163 knots, this gave a rate of speed of only 17.74 knots. Later, when the liner tied up at her dock in Hoboken, it was learned that she had been delayed by trouble with the machinery. The extent to which this affected the trip is seen on an inspection of the daily runs, which were: 406, 442, 395, 472, 378 and 460 knots. The "Kaiser Wilhelm der Grosse" has a daily run of 580 knots to her credit. It was at once manifest that the trip across gave no line whatever upon the capabilities of the ship.

Before referring at any length to the causes of the delay it will be well to note some of the dimensions and chief characteristics of this splendid ship. In many respects she is a distinct departure from the usual type of transatlantic liner. The experience her builder has gained in the construction of fast war vessels was turned to account in this ship, and several novelties of design are the result. Indeed this shows that originality and boldness in departure from traditional methods which frequently marks distinct progress. In general dimensions the Kaiser Friedrich is 600 ft. long, 64 ft. beam and 41 ft. deep from keel to upper deck. Her gross tonnage is 12,000 tons, and displacement at 28 ft. draught 17,000 tons. In form she is extremely fine at the ends, with a remarkably sharp straight entrance. Her funnels are three in number, elliptical in section, and she has two pole masts, the combination making an extremely trim looking vessel, in which the only disfigurement is a multiplicity of cowls above the boat deck. A watertight double bottom is worked the entire length of the vessel, and the hull is divided into eighteen watertight compartments by seventeen bulkheads, of which fifteen extend to the upper deck and two to the main deck. It is calculated that should any three compartments be flooded simultaneously, the vessel would still retain sufficient buoyancy to float.

The "Kaiser Friedrich" has been constructed in accordance with the German Lloyd's rules, also those of the United States Government, and she meets the special requirements laid down by the Imperial German Navy for the construction of auxiliary cruisers. These include the laying out of gun emplacements and local stiffening of the hull, and special construction of rudder and location of steering gear. In the machinery department the chiefest novelty is to be found. The engines are located about 15 ft. further forward in the ship than usual in liners. They are of the five-cylinder, three-crank, quadruple-expansion type, together capable of developing 25,000 indicated horse power. In dimensions the cylinders are: high pressure 43.34 in. dia., first intermediate 64.20 in. dia., second intermediate 92.20 in. dia. and (two) low pressure 93.58 in. dia. by 66.975 in. stroke. The sequence of cylinders is: high pressure and low tandem over forward crank, second intermediate over middle crank, and first intermediate and low pressure tandem over after crank. Piston valves are fitted to the high pressure and first intermediate cylinders and single ported Trick slide valves to the others. Upon descending into the engine room the visitor can hardly believe his eyes that he is aboard a big liner; he rather fancies himself in the engine room of some great war vessel. The engines are designed upon the lines of those now invariably fitted in warships, with turned steel columns 10 in. dia. instead of the usual heavy looking columns, and in fact no cast iron is in sight except the cylinders and valve chests. The crank shaft bears out the illusion, as it is of the design now used in our naval vessels. Each engine shaft is made in three pieces, of Krupp's nickel steel, and is 42 ft. 6 in. long, by 23.64 in. dia. in the bearings. The crank pins are 29.15 in. long, and 23.64 dia., with a 8.67 in. through hole; the outside corners of the slabs at the pin ends are chamfered. This tends to give the crank a light appearance, in striking contrast to the ponderous built up cranks on many other liners. The connecting rods are 12 ft. 5.7 in. long, center to center. Stephenson link motion is fitted throughout, and there is a single eccentric on each shaft for working an expansion valve. These valves were found to be too effective in practice, and were removed at Southampton on the trip out. Air, bilge, and cold-feed and sanitary pumps are fitted to the main engines and worked in the usual way, by rocking levers. There is a full equipment of auxiliaries, including a hot feed system, and various fire, bilge, ballast, sanitary and centrifugal circulating pumps. The location of the engines so nearly amidships necessitated the use of rather longer shafting than usual in a vessel of this power. Over all, the starboard shafting measures 244 ft. 4 in., and, as the propeller blades overlap slightly, the port shafting measures 247 ft. 9 in.

Coming back now to the cause of delay on the voyage across; this was due entirely to the failure of the slide valves to work smoothly and to the

breakage of studs in the air pump buckets, so that a proper vacuum could not be maintained. With slide valves of the single ported type, the travel is extensive, and this, with the great dimensions of valve necessary, and the rapidity of the stroke (86 engine revolutions at full speed) caused excessive wear. It is probable that the relief frames became practically useless, as a consequence, leaving the entire backs of the valves exposed to the receiver pressures. The tremendous strain thus thrown upon the rods and gear would make a reduction in speed of engine revolutions an act of common prudence. A slide valve of these dimensions, even when of the multiple-ported type, with comparatively little travel, is an unpleasant piece of mechanism in an engine room. German engineers, however, as a class, seem to favor the slide valve for the low pressure cylinders of large engines. The difficulty with the air pumps was one which might, perhaps, have been anticipated. The buckets are of a long familiar type, with heavy metal valves held in place by phosphor bronze studs. At the high rate of engine speed at full power the hammering effect of the water broke off studs close to the bucket, causing, of course, serious leakage. This is not a new experience by any means in marine work and could likely be easily remedied by the substitution of metal discs, or similar valves, for those now in use, without any alteration of the pump itself.

Under the circumstances it is not a matter of wonder that the "Kaiser Friedrich" did not break any records; but rather her time for the voyage is a high testimonial to the skill of the chief engineer, Herr Ottomar Michael and his staff. During the voyage no trouble whatever was experienced with the shafting, either crank, thrust, or line.

In the boiler equipment will be found another departure from the orthodox. A boiler room has been placed aft of the engines. There are ten boilers in all in the ship. Nine of these are double-ended and one single-ended. Three double and the single are fitted in the forward boiler compartment, three double in the compartment next aft and three double in the compartment aft of the engines. Eight of these boilers are 16 ft. 8 in. dia. and 21 ft. 3 in. long, and are fitted with eight furnaces each. One furnace in each end opens into a common combustion chamber and the grates are unusually long. The furnaces are Purves' ribbed and the tubes are plain, fitted with spiral retarders. In the after compartment, abaft the engines, there are two boilers of these dimensions, one on each side, and in the center one smaller boiler with six furnaces only, which is set across the tops of the tunnels. The pressure carried is 225 lbs. per sq. in. Howden hot draught is fitted to all the boilers.

The propellers are three bladed, made of manganese bronze, with adjustable blades, and are 20 ft. 4 1-2 in. dia. and have now 31 ft. 5 1-2 in. pitch. They turn out when going ahead.

An inspection of the machinery equipment produces in the visitor, of mechanical perception, that indescribable feeling of satisfied contemplation which artists are said to experience on viewing a masterpiece. There is the mark of the trained draughtsman and mechanician on everything visible; not only do general outlines harmonize and show good geometrical proportions, but little details are worked out with true engineering skill. The only criticism, indeed, which can manifestly be made, is that there has been a too rigid economy of space, which, however, from the owners' and passengers' points of view is a merit. It is greatly to be regretted that such a splendid ship should have been sent to sea without adequate trials, and thus have been subjected to undeserved criticism by non-technical persons. Fine warship performances, which most Navies refer to boastingly are, notoriously, made only after it has been carefully ascertained that the ship will do what is expected of her. A 3,000 mile trial trip at full power is a serious ordeal for a new vessel, in which the designer has incorporated some original ideas. Prophecy is a dangerous rock, but we would feel quite safe in asserting that if the "Kaiser Friedrich" does not "break the record" she will come so near it that chronographs will have to be used to decide who wins.

It has been decided by North German Lloyds to send the vessel on her homeward trip without passengers, June 25. Using the high pressure and first intermediate cylinders, which are fitted with piston valves, the engines will be run compound, and a speed of 10 knots is looked for.

Vessels Recently Added to the Navy.

We here publish a list of vessels recently purchased by the Navy department not included in the lists which appeared in our May and June issues. Since the publication of the June list changes have been made in the names of the former revenue cutter Algonquin and the tug El Toro. The El Toro was among the vessels first purchased by the Navy and was then renamed the Algonquin. Later, when the revenue cutter Algonquin was transferred to the Navy, the renamed tug Algonquin (formerly El Toro) was at sea, and it was decided to rename the revenue cutter Algonquin the "Accomac" so as to avoid confusion in orders. This change was not acceptable to the Treasury officials and a change of names was again effected by which the name "Algonquin" was restored to the revenue cutter and the name "Accomac" transferred to the former tug El Toro (temporarily the Algonquin).

In the June issue the new name of the Galveston tug Hortense is omitted. This boat is now known as the "Takoma."

Various other vessels have been inspected by the naval board organized for this purpose. The lists published include those actually in service.

WARSHIPS AND AUXILIARY VESSELS RECENTLY ACQUIRED BY THE UNITED STATES NAVY BY PURCHASE, CHARTER OR TRANSFER (*THIRD TABLE*).

Old Name and Date.	Old Class.	Length.	Breadth.	Depth.	Draught.	Tonnage.	Horse Power.	Speed, Knots.	Where Built.	Hailing Port.	Former Owners.	New Class.	New Name.
Atala, '94	Steel freighter	330	43	26 3	....	3,250 reg.	267 N.	9	Stockton, England	London	New Blue Star Line, Ltd	Collier	Alexander
A. W. Booth, '98	Steel Tug	92 10	19	10	8	208 disp.	300	10.5	Seattle & Levy	New York	Michael Moran	Tug	Massasoit
City of Peking,* '74	Transpacific liner	423	48	27 8	....	5,080 gross	...	14	John Roach	San Francisco	Pacific Mail S. S. Co.	Miscellaneous	City of Peking
Comanche, '92	Auxiliary yacht	184 6	25	14 3	11	357	550	11	Globe Iron Works	Cleveland	H. M. Hanna	Aux. gunboat	Frolic
Dorothea, '98	Yacht	215	23 3	15	10	.....	...	16.5	Cramp	Philadelphia	Estate of Thos. McKean	" "	Dorothea
East Boston, '92	Twin Sc. Ferry	163	57	14	8 10	762 gross	700	12	East Boston	Boston	Street Dept., Boston.	Lighter	East Boston
Enquirer, '96	Yacht	143 7	17 6	10	6	140 56	...	18	UnionDryDock,Buff.,N.Y.	Buffalo	J. W. Connors	Aux. gunboat	Enquirer
Eugenia	"	149 6	19	11 6	10	165 gross	360	11.75	Leith, Scotland	Philadelphia	J. G. Cassatt	" "	Vixen
Governor Russell, '98	Twin Sc. Ferry	164 3	57	14 1	9	713	700	12	East Boston	Boston	Street Dept., Boston	Lighter	Gov. Russell
Huntress, '95	Yacht	120	16	9	6 6	81.76	650	16	C. L. Seabury	Hartford, Conn.	F. C. Fowler	Aux. gunboat	Huntress
Inca, '79	"	92 6	20	9 5	7	103 gross	200	12	Philadelphia, Pa.	Brunswick, Ga.	South Atlantic Tow. Co.	" "	Inca
J. D. Jones, '89	Wood Tug	140 9	29	12 4	11 6	298 gross	525	10	Tottenville, N. Y.	New York	Merritt Wrecking Co.	Tug	J. D. Jones
Kate Jones, '79	Iron tug	102 5	20	10 6	....	122 gross	125 N.	....	Camden, N. J.	Boston, Mass.	.....	"	Seminole
Peter Jebsen, '91	Freighter	321 5	41 5	21 9	....	3,070 gross	283 N.	8	South Shields, England	Bergen	Bergh & Heiland	Collier	Brutus
Rhaetia,† '83	Steel freight and pass'r steamer	351 6	43	29	....	3,458 gross	440 N.	10	Hamburg, Ger.	.....	.....	"	Cassius
Scindia, '90	" "	375	46	27	....	4,358 gross	440 N.	12.5	D. & W. Henderson, Glasgow	Glasgow	Henderson Bros.	"	Scindia
Shearwater, '87	Yacht	1 0	18	10	8	109 gross	220	11	Boston, Mass.	New York	H. R. Wolcott	Aux. gunboat	Shearwater
Stranger, '80	"	190 5	23 8	11 6	10 6	247 gross	...	....	Cramp	"	Mrs. Mary Lewis	" "	Stranger
Whitgift, '95	Steel freight and pass'r steamer	312	41	20 6	....	2,925 gross	246 N.	9	Sunderland, England	London	Houlder, Middleton & Co.	Collier	Nero

* Sailed with Stores, etc., for Admiral Dewey's Squadron.

† Formerly in Hamburg-American Fleet.

Additional Particulars of the Manila Fight.

The story of the sea fight at Manila told by the cables has been supplemented during the month by details brought by mail. Indeed the Navy Department has received the official report of Admiral Dewey, and many letters from officers and men of the American squadron have been received by their friends at home. Most interesting of all, however, are the sketches of the wrecked Spanish vessels made on the spot by John T. McCutcheon, the special artist-correspondent of the *Chicago Record*. Through the courtesy of this metropolitan newspaper we are enabled to vividly show our readers the actual effects of the American fire.

Mr. McCutcheon was on board the Revenue Cutter McCulloch, which accompanied the squadron from Hong Kong to Manila and which, thought it did not participate in the fight, remained within visual distance guarding the transports, and after the fight rejoined the other vessels. One of the views shows the incident of the fight referred to by Admiral Dewey in his report thus: "At 7 A. M. the Spanish flagship Reina Christina made a desperate attempt to leave the line and come out to engage at short range, and was received with such a galling fire, the entire battery of the "Olympia" being concentrated upon her, that she was barely able to return to the shelter of the point. The fires started in her by our shell at the time were not extinguished until she sank."

In his report of the Manila fight Admiral Dewey states that the American squadron opened fire at 5.41 A. M., May 1, the range varying from 5,000 to 2,000 yards as the fight proceeded. At 7.35 A. M. his ships ceased firing and withdrew for breakfast. At 11.16 o'clock he returned to the attack, at which time the Spanish flagship, and almost all the Spanish fleet, were in flames. At 12.30 P. M. the squadron ceased firing, the land batteries being silenced and the enemy's ships sunk, burned, or deserted. Afterwards the gunboat Petrel was sent to complete the destruction of the gunboats sheltered by the point of Cavite. "I am unable to obtain complete accounts of the enemy's killed and wounded," continues Admiral Dewey, "but believe their losses to be very heavy. The "Reina Christina" alone had 150 killed, including the captain, and 90 wounded." Mr. McCutcheon writes to the *Chicago Record*, after a careful investigation, his belief that 400 were killed and 600 wounded.

During the engagement the Spaniards fought with the most desperate bravery, which makes our victory all the more creditable. Their firing, however, while rapid was ineffectual, owing to wretched aiming, and Admiral Dewey reports: "the damage done to the squadron was inconsiderable—none killed and only seven men slightly wounded. Several of the vessels were struck and even penetrated, but the damage was of the slightest."

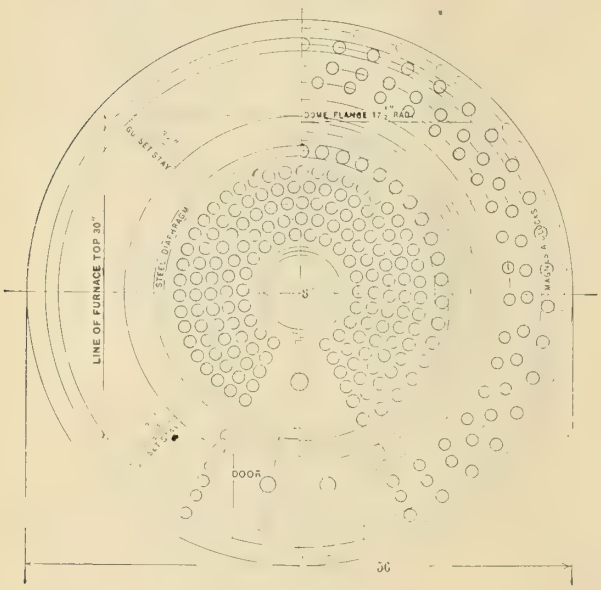
1. Wreck of wooden cruiser Castilla in Canacoa Bay.
2. Wreck of steel cruiser Reina Christina, Admiral Montejo's flagship.
3. Sailors from U.S.S. Olympia blowing up a shore battery.
4. Wreck of the iron cruiser Don Antonio de Ulloa in Canacoa Bay.
5. U.S.S. Olympia driving back the Spanish flagship which had come out to meet her.

WITH ADMIRAL DEWEY AT MANILA.—COPYRIGHT, 1898, BY THE *CHICAGO RECORD*—REPRODUCED BY PERMISSION.

IMPROVED APPATATUS.

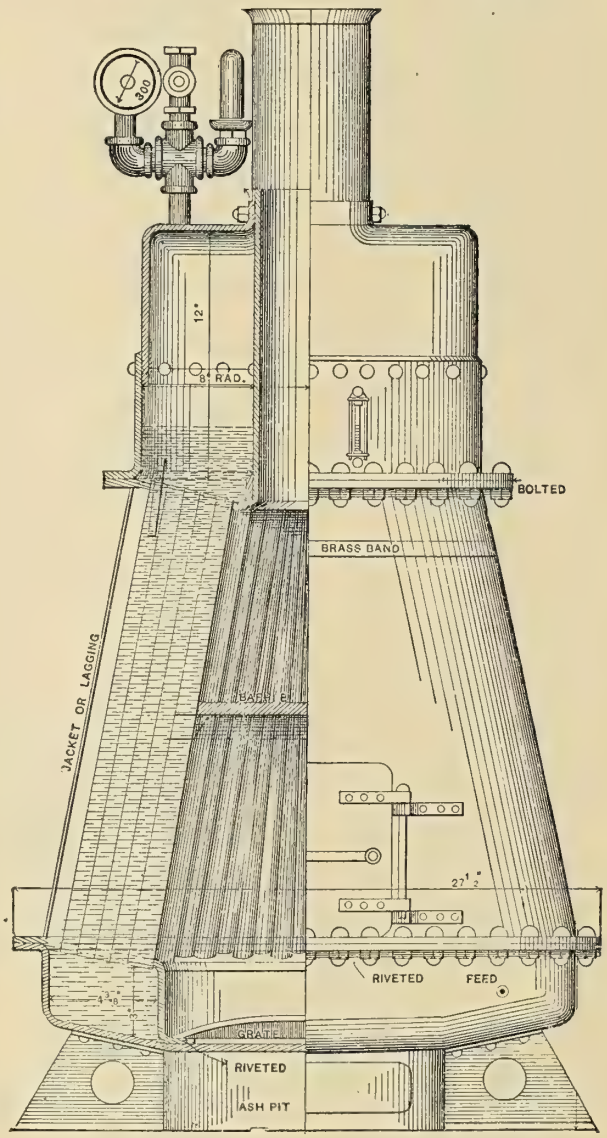
Watson Radial Water-Tube Boiler.

The construction of the Watson water-tube boiler is very plainly shown in the accompanying engravings. The tube system is in the form of a cone, inclined over a central furnace, the gases from which are diverted between the tubes by a baffle-plate, in the upper part, directly under the smoke-pipe. The tubes are secured in place by expanding the ends in the tube sheets, which are inclined so that the tubes are at right angles to them. The smoke-pipe is screwed into the tube-sheet and passes through the steam dome, to which it is connected on the upper end—where it emerges—by a metallic packed slip-joint, and by bolts passing through the neck of the slip-joint at right angles. The various elements are riveted together, with the exception of the flange connecting the steam dome with the boiler proper.



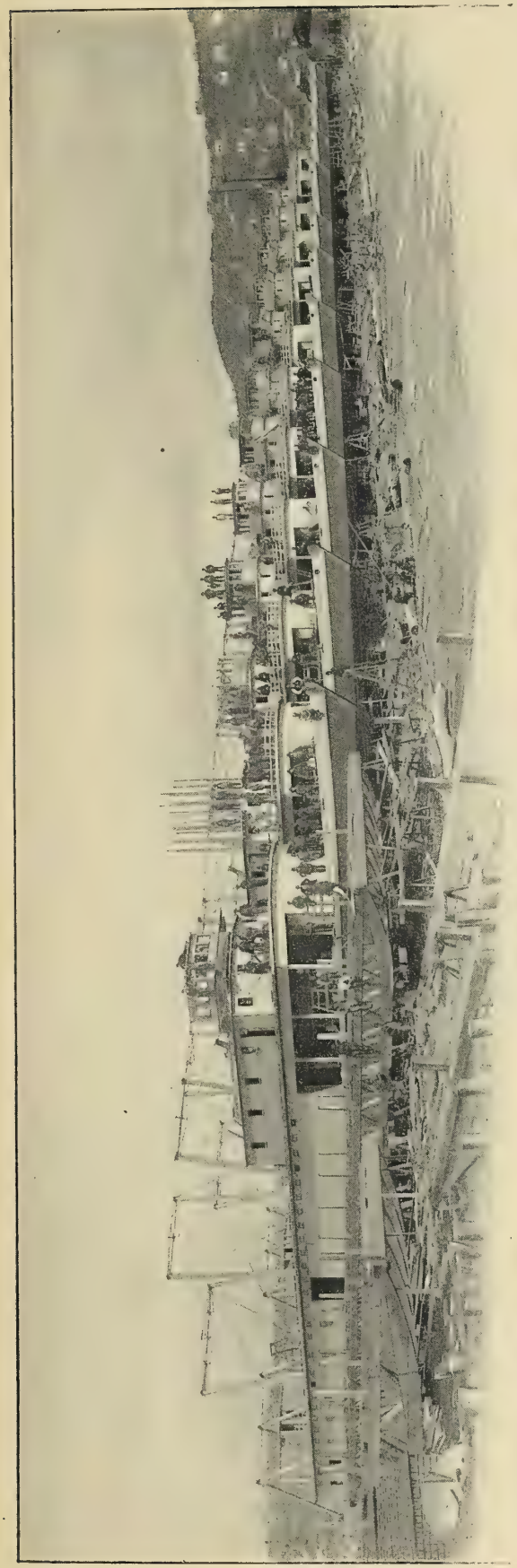
PLAN OF THE TUBE SYSTEM.

This is bolted together and so is readily removable for cleaning and inspection of the interior. To secure a rapid and constant circulation a steel plate diaphragm is introduced between the outside row of tubes and the inner rows and extending from top to bottom, with the exception of the fire door opening. Consequently the down cast tubes receive no direct heat from the furnace and are comparatively cool. The water rising through the steam tubes passes over into the downcast pipes to the water bottom. Here any impurities held in suspension are deposited and can be readily blown out. The grates—which are put in through the door—and the ash-pit are easily accessible. The latter is bolted to the water bottom and can be easily removed and renewed when worn out. All boilers are constructed throughout of marine steel of 60,000 lbs. tensile strength and are built to pass government inspection and to carry 225 lbs. per sq. in. working pressure. The manufacturer guarantees a rate of evaporation of 6 to 8 1-2 lbs. of water per pound of good coal, according to the conditions which prevail on trial. He has subjected one of these boilers to severe tests, such as letting the water get below the gauge cocks and severely forcing the boiler beyond its capacity without any serious results. In water-tube boilers the contained water is very small in quantity, but in this type the contained water is 30 per cent of the weight of the boiler empty. On a test with a boiler having 2.75 sq. ft. of grate surface and 82 sq. ft. of heating surface, a rate of evaporation of 170 pounds of water per sq. ft. of grate



SECTIONAL SKETCH WATSON BOILER.

surface, with feed water at 40 deg., was reported. The stack used was 36 in. high, and the draft did not exceed 1-2 in. of water. On an engine consumption of 30 pounds per hour this would give 17 horse power, or a horse power for every



STERN-WHEEL STEAMBOATS FOR THE YUKON, UNDER CONSTRUCTION IN THE YARD OF MORAN BROS., SEATTLE, WASH.

5 sq. ft. of heating surface. Emphasis is laid by the manufacturer upon the light weight and small dimensions of the boiler for a given horse power, when compared with tank boilers. The boiler shown in the elevation has 100 sq. ft. heating surface; 3 sq. ft. grate surface. Its total height is 5 ft. and extreme width 3 ft. 11 in. and the weight laid down ready to steam is 1,300 pounds. This boiler is sold under a guarantee that it will come up to contract requirements. The inventor, patentee, and manufacturer is E. Pomeroy Watson, Elizabeth, N. J.

Proposed U. S. Seagoing Battleships.

Bids will shortly be called for by the Navy Department for the three seagoing coast line battleships recently authorized by Congress. The following general characteristics will be embodied in the designs proposed by the Department: Length, on load-water line, 368 ft.; beam molded, at water line, 72 ft.; mean draught at normal displacement, 23 1-2 ft., normal displacement about 11,500 tons. They will carry armor varying from 16 1-2 in. to 2 3-4 in. in thickness, according to position. The main batteries will consist of four 13-in. B. L. guns, mounted in barbette turrets, one forward and one aft, ten 6-in. R. F. guns in broadside on the main deck, and four on the upper deck within the superstructure. The secondary batteries will consist of twenty-four R. F. and machine guns. These ships will have twin screws, single-ended cylindrical boilers and the bunker capacity will be 1,200 tons. They will have a sea speed of 16 knots. Heavy penalties will be imposed for any deficiencies in speed at the time of trial.

Stern Wheel Yukon Steamers.

A round dozen large river steamers under construction in the yard of the Moran Bros. Company, at Seattle, Washington, are shown in the accompanying engraving. The keels for all these vessels, which are intended for Yukon river trade, were laid since January 1 last. They are alike in all particulars of dimensions, material and equipment. The principal dimensions are: Length, 175 ft.; beam, 35 ft.; depth of hold, 6 1-2 ft. Each is fitted with a stern wheel, with engines having cylinders 20 in. dia. and 84 in. stroke, and three cylindrical tubular boilers 44 in. dia. and 16 ft. long, with 82 2 1-2 in. tubes. These vessels are fitted with steam capstan, steam and hand steering gear, and electric light throughout, including a 2,000 candle power searchlight in the pilot house. Each has cabin accommodation for twenty-four passengers and "standee" berthing on the main deck for 200 more. All freight is carried in the hold. The freight carrying capacity of each steamer is 400 tons on 48 in. draught. The hulls and all the machinery, with the exception of the pumps and electric lighting sets, were constructed by the Moran Bros. Company.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.
S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representatives.
L. L. CLINE, Detroit, Mich., 47 Hodges Building.
B. M. GARDNER, Chicago, Ill., 1522 Monadnock Block.

Traveling Representatives.
E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:
Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

ONE result of the naval operations, so far, has been a better understanding by the public of the duties and responsibilities of the staff officers of the Navy. In peace time they were, of course, in the background, while their brethren of the line were equally prominent on all occasions of social or professional occupation ashore or afloat. It was the captain and his corps of line assistants who, in splendid blue and gold, welcomed the influential visitor at the side and showed him or her the methods of handling those dreadful guns, and other terrible engines of destruction. There were places in the ship, and spacious ones, too, in which strange masses of metal were stored; but these were dark and uninviting and smelled like a scullery, and usually the visitor did not investigate. It was in these dark and cavernous engine and boiler rooms that the engineer—plain Mr. So and So—was usually hidden. It is a peculiarity of the engineering branch of marine work that, frequently, its members have more to do when in port than when under steam. A deck officer can dismantle a gun when the vessel is steaming at full speed, while no engineer can take an engine adrift under the same conditions. In fact, in his case, it is the work done in port which makes possible the speed of the ship at sea. As we remarked, the lessons of the past weeks have had a distinct educational value. There has been the spectacle of the ships of the Spanish Navy, with powerful batteries and manned by brave officers and men, useless for offensive operations, because either their machinery was not in condition to put to sea or when running was beyond the capability of the engineers to properly control. On our side there have been the magnificent demonstrations of engineering skill in the home runs of the "Marietta" and the "Oregon." The 13,000 mile run of the latter from San Francisco 'round the Horn to Jupiter Point, Fla., where she cast anchor in American waters again, is an achievement that shows what our engineer officers are capable of. No delays were experienced other than the brief stops in port, on the way, to provision and coal; and at the end of her trip, after coaling up, she was ready to take her place in line of battle. And the little "Marietta," a thousand ton gunboat, made an almost continuous trip from Sitka, Alaska, to Key West, Fla., commencing on December 9, 1897. and ending June 4 last. Coming to personal deeds what words can give proper credit to the bravery of Richmond Pearson Hobson, a member of the distinguished corps of naval constructors? In this connection the professional courtesy of Admiral Sampson, in giving Mr. Hobson the opportunity to carry out his plan of sinking the "Merrimac," in the fairway at Santiago, should not be forgotten. Contrasting the work of our ships in actual warfare with that accomplished by foreign vessels during peace manoeuvers, the results are a cause for great satisfaction. Not a vessel of importance has seriously broken down in its machinery equipment, while in the foreign manoeuvers there were invariably many serious mishaps.

THERE is, perhaps, no form of apparatus for marine use which has a greater future than the internal combustion engine, usually termed the gasoline or gas motor. The growth of this branch of construction indeed has been remarkable, but if signs go for anything the business has made little progress compared with what is to come. Hitherto the application of the gas motor has been confined largely to pleasure boats, but improvements in design and construction, on the part of the manufacturers, and a better appreciation of the possibilities of this form of engine, on the part of the user, are ever increasing the range of application to purely commercial uses. In the line of pleasure craft, however, which we have more in mind here, there is

a great future. Persons who cannot afford the initial expense and cost of maintenance of a small steam yacht can now get a comparatively inexpensive boat which will not heavily tax their incomes for upkeep. Such persons desire to own a boat in which they can entertain themselves and their friends with the social privacy which is not possible in excursion or pleasure steamers however well appointed. Nor do they care for the pleasures of the sail boat, which, if spacious compels the carrying of a crew, either amateur or professional, and which is decidely inefficient in manoeuvring capacity in the best of weather, and a conveyance of questionable comfort in calm or storm. With the motor boat there is a source of power independent of wind and tide, and provided a few simple preliminaries, such as keeping a full oil tank, are attended to, it is ready for immediate service at any time of day or night. There are no fires to light nor sails to set and no delays other than a few brief moments to start the motor. If the owner is fond of things mechanical he can act as his own engineer without fear of the law. In connection with the growth of this branch of marine construction there is one feature which is detrimental and which cannot be reasonably explained. We refer to the hugger mugger methods of some motor builders. When an intelligent customer comes along, and the prospective purchaser of a motor boat is usually a man of more than average intelligence, he is treated to a plausible, if not garrulous, explanation of the merits of the apparatus, but when explicit information is asked for it is not forthcoming. If the customer is versed in mechanical matters he is more or less disgusted, and if he is innocent of such knowledge he is very likely to be imposed upon, and later becomes an enemy rather than a friend of this mode of propulsion. Let us illustrate this matter by an actual occurrence. At a recent exhibition in New York a gentleman of our acquaintance, who is particularly well informed on engine construction, and who had received a commission from a friend to purchase a marine motor, approached an exhibitor. The general appearance of the motor exhibited rather impressed our acquaintance, and after some general inquiries as to power and weight, etc., he asked for details of the valve gear. On this the exhibitor flew into a furious passion and demanded to know by what right his questioner had made such an inquiry. The gear was the result of many years labor of the exhibitor and patentee, and it was little short of infamous to ask him to divulge these marvelous details. When he had finished our acquaintance inquired: "Do you suppose I would purchase an engine upon your assurance that it was 'all right,' and that it 'would do the work,' without making any investigation and forming my own judgment?" When the exhibitor found that a sale was in jeopardy he tried to justify himself, though still declining to give any technical description of his engine. This is not an isolated case, for other manufacturers maintain a Chinese attitude when questioned, and try to cover their actions by vague talk about the insecurity of the patent system. Contrasting this conduct with that of the steam-engine builder the inference is such gas motors are like Peter Pindar's razors—made to sell. There is no law which would prevent any one so minded from purchasing any type of motor in the market and disconnecting it at his leisure, with calipers and rule at hand. Reputable builders of steam engines desire the customer to know exactly the design and advantages of an engine down to the minuetest bolt, and why should not this apply to gas motor builders? Is it because the builder, having no confidence in his engine himself, is afraid to risk the criticism of others? Would any builder assert that a man who operated a motor boat should put out to sea with an engine the construction of which he was totally ignorant of, and face the possibilities of a breakdown in bad weather? This, however, is the position in which an unsuspecting buyer would find himself. The foregoing does not, of course, apply to gasoline engine builders in general, but there is more of this sort of thing in the business than is good for it. Such methods are unscientific and illiberal and savor very strongly of charlatanry. It is by the interchange of ideas and experiences that improvements are possible, and the business is of sufficient magnitude to give room for its conduct on broad lines. Mystery only increases the apprehensiveness of the many who have not got over viewing the motor boat as a sort of animated torpedo. To our readers, many of whom are interested in all that pertains to motor boats, we would say by way of caution: Do not put implicit confidence in general and vague statements of manufacturers, but insist upon knowing the why and wherefore of design and construction, and if not competent to judge yourself get some unbiased advice.

A Landsman's Trip in a Torpedo-Boat Destroyer.

I had rather a novel and interesting experience the other day, says a writer in *Chambers's Journal.*

Being in town, on sick leave from my regiment in India, with nothing to do, and lots of time to do it in, whilst eating my dinner at my club and vaguely wondering how on earth to spend that portion of the next twenty-four hours which was not night, I suddenly remembered that one of my old school-chums was in the navy, and furthermore that the last time he had written me he had mentioned that he was in command of one of the torpedo-boat destroyers belonging to the instructional flotilla at Chatham.

I hadn't his letter by me, and I was not at all certain whether it was Chatham or Sheerness, not being at all well up in things naval; but still, when I went to bed that night I registered a vow that, as time was weighing heavily upon me, the next morning I should seek for Vincent somewhere in the Medway; which vow I kept, as rising early, after breakfast I went down to Chatham, drove to the dockyard gates, and, being young and innocent, dismissed my cab.

On inquiry at the Chatham dock-gates as to whether H. M. S. Fury was in port, I had the good luck to be told, "Yes, sir; you will find her down at the South Lock. It's rather a long way, sir, and she's going out this afternoon."

Within half an hour, and after some uneasy experiences over dockyard cobbles, I came within sight of the "Fury." She certainly was not pretty; but her great length and narrow beam gave me the impression that her speed must be very great; whilst her sloping forecastle, the twelve-pounder gun on top of the fore-bridge, her other guns distributed about the deck, her torpedo tubes, and, above all, her three large funnels, filled me with the idea that she had power in her to strike, if need be, and that she would be a formidable, or at least dangerous, implement in the hands of daring officers and well-trained men.

She was painted black all over, with the exception of a white line around her just under the upper deck.

Going on board, a bluejacket, who turned out to be the quartermaster, stopped me at the gangway and asked what I wished. I gave him my card, and inquired if the captain was on board.

"Yes, sir," he said. "Please follow me."

I did so, but very gingerly, being in constant fear of tripping over valve-guards, eye-bolts, stays, etc., (these names I found out later on), with which the deck was covered, so that just as I got aft up came my old chum from below.

"Hullo, old fellow!" said he, with surprise showing all over his sunburnt face; "I never expected to see you down here. Come down below and tell me all about it."

He disappeared down the hatch, so I followed cautiously. It was just as well I did so, for at the bottom of the ladder gaped a large square hole, in the center of which was the upper half of a man's body, whom I nearly kicked.

"Oh, they're only getting up the rum," said Vincent. "Come in."

I didn't like these man-traps at all, and I told him so; but I went in, and found myself in a very cosy square room, about four yards long by six yards broad, with just room to stand upright. This was the "ward-room," and here I found the "sub" correcting some charts, and the "gunner," to both of whom Vincent introduced me.

"We're rather busy this morning," said Vincent, lighting his pipe. "We have only come up here to get a new class of stokers on board after having trained and discharged the old set; and we're going out in about ten minutes' time. You were very lucky to catch the ship at all. Look here! You had better come out for the day with us. You'll see a little of what destroyer life is like, and it will give you a bit of a blow through and an appetite. We shall land you at Sheerness afterwards, unless you care to stop for the night."

At once I acquiesced, and being left alone for a little, I had time to survey my surroundings.

Facing the door was a stove and a small sideboard, with a bookcase above, filled with books on service matters, such as channel and North Sea pilots, light lists, tide tables, etc.; a paper-rack and a wine-locker, a pipe-rack, block, chronometer-box, and one or two little nicknacks filled up that side.

On either side of me were the bunks, of which altogether there were three. These bunks, though narrow, seemed very comfortable; they were fitted with drawers underneath, and a small wardrobe was fixed at the head of each bunk. On one side, also, was a chart-box and a looking-glass, whilst behind me were lying a pile of sea-boots, and on the bulkhead were hung coats, mackintoshes, oil-skins and sou'-westers. Glancing up overhead, I saw camp-stools, swords, golf-clubs, sticks, tennis-rackets, fiddles for the tables in rough weather, etc. My friends on board knew how to pack, evidently, for not an inch of space was lost.

Having thus completed my inspection of the ward-room, I looked outside: on my left a very diminutive pantry; on my right a bath-room in like proportions, with two washing arrangements similar to those one sees in a railway carriage, and also an indiarubber bath.

Getting tired of stopping down below, and yet fearing to be in the way, I went on deck. To my surprise, I found all the men forward, and that we were quietly steaming down the Medway.

I was standing on the quarterdeck, with a six-pounder gun on a platform in front of me, which gun was reflecting the sun's rays in my eyes and dazzling me, so beautifully clean and nicely-polished was it. Behind me was a screen, sheltering the "after-steering position," fitted up, I found out later, exactly as the one forward was. There was also a hatch which led down to the captain's cabin, outside of which were store-rooms and racks for rifles and cutlasses. The cabin was a nice little place, and had a bunk, wardrobe, writing-table and bookcase, and also a little bath-room outside, but no stove. The captain in these ships messes in the ward-room, and only uses his cabin for sleeping in and for correspondence work.

Walking over the platform, I found a torpedo-tube, and alongside it a hatch, which, on inquiry, I was told led to the chief petty-officers' mess. It was quite a little place, about half the size of the ward-room. The engine-room artificers have a similar mess on the other side of the deck. Everything was beautifully clean, and the table was quite white from hard scrubbing.

Going farther forward, my olfactory organ was tickled by a most savory odor, and on looking down another hatch I found that here was the galley, and beside it stood the ship's cook hard at work getting the dinners ready. There was also here a dynamo for supplying electricity to the search-light, which latter was placed between the engine-room hatches on deck.

I now came to the engine-room, but did not go down just yet. Passing the big after-funnel, I came on an open space, and a couple of bluejackets, who were splicing a wire rope, volunteered the information that this was where the foremost torpedo-tube would be placed when the ship was used solely as a torpedo-boat. Here I was joined by the "sub," who apologized for his sudden ascent from the ward-room, and offered to show me round the rest of the ship, as the captain could not yet leave the bridge for any time.

I rather liked the rig he was in—a thick pilot coat, ditto trousers, a football-sweater, with a white silk scarf in lieu of a collar, a fairly old cap, heavy but close-fitting leather sea-boots, thick gloves, and a pair of binoculars slung round his neck, formed his

attire; which, as he went forward, I could not help thinking was, for this sort of rough-and-ready life, absolutely the best he could wear.

Between the two foremost funnels is the standard compass, with the flag-locker underneath it, and a chart-table, all of which the "sub" pointed out.

"How many men are there on board?" said I.

"Oh, our complement is fifty-two all told; but about thirty of these are stokers for training in the working of water-tube boilers, and they are changed every month. This is their mess-deck. The magazine and shell-room for the twelve-pounder are under here also."

"There's not much room for thirty, is there?" hazarded I, drawing a bow at a venture, as I felt I should say something.

"Well, no, there's not very much; but they get along all right. You see, some sling their hammocks, and the others sleep on the lockers; and if they are cold they use their duffle suit, which consists of a pair of trousers made of very thick fearnought, and a big coat of the same material with a hood attached, and it is fitted with beckets and wooden toggles for fastening and I think that chap up there would give a pretty good account of himself."

He pointed up at the gun on the fore-bridge as he spoke, and I agreed with him, and inwardly determined that any further acquaintance I might make with "that chap up there" should be made from behind, and not from in front.

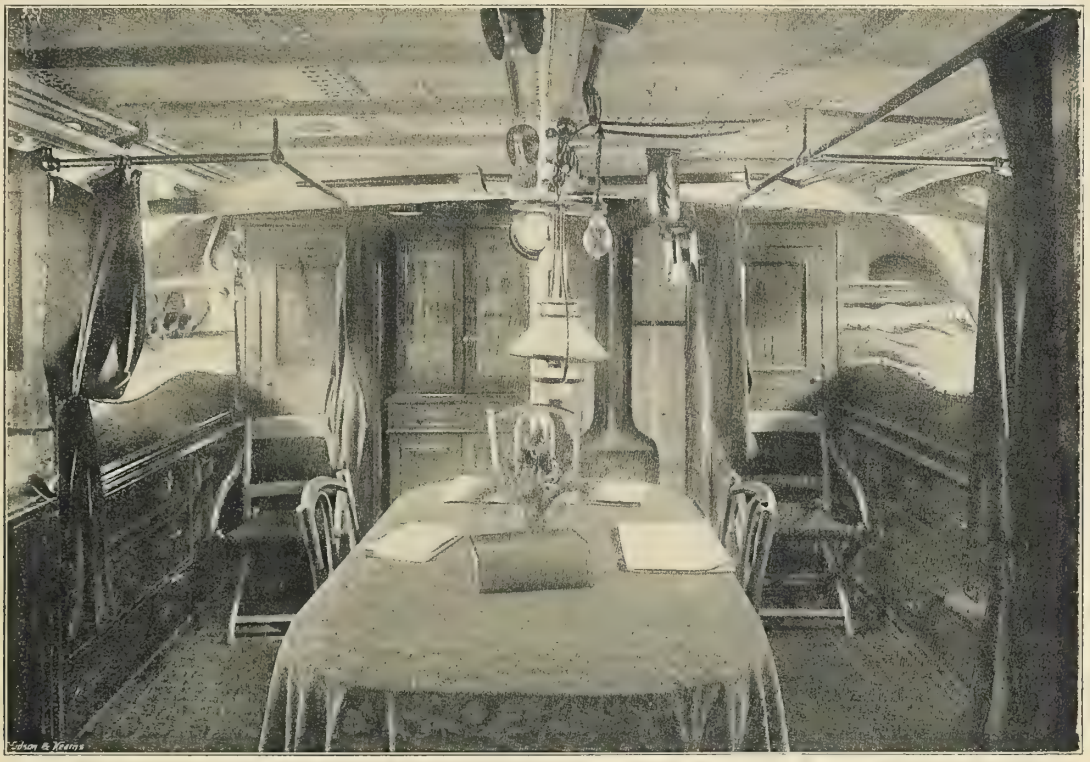
"The ship seems very long," I said; and, being rather curious on this point, I added, "What length is she?"

"Oh, about two hundred feet," he answered.

"And her beam?"

"That is about nineteen and a half feet, and she draws about six. See here; this is the conning-tower, with our half-inch of armor on it. Isn't it a lot? We can steer from here, and in bad weather we have to, as one would be washed away on the bridge."

I looked inside. There was just room for two people to stand up inside, and it was fitted with a compass, steering-wheel, telegraph to the engine-room, and voice-pipes to the torpedo-tubes and various other parts of the ship.



WARD ROOM AND OFFICERS' BERTHS ON TORPEDO-BOAT DESTROYER.
(Reproduced from the Army and Navy, London.)

it by. We (the officers) find them very useful to put on over our oilskins during a bad night's run. You can't get very wet, and they keep you as warm as toast.

"Do you know what this is?" he said, to change the subject. "It is a collapsible boat. We have two, one each side, you see. They are hoisted out by that derrick on the mast, and if we had to abandon ship they would take seventeen men each, and provisions for them as well.

"You see the deck is covered with a kind of linoleum; it is found to answer much better than wood in this class of ships, as also in torpedo-boats. Here are two six-pounder Hotchkiss guns; these and the twelve-pounder up there constitute our bow-fire. Pretty strong for so small a ship, isn't it? You see, our object is to overtake and destroy by our superior gun-fire an enemy's torpedo-boats; consequently, when chasing, bow-fire would be of great importance,

"You say this is only half-an-inch thick?" I queried. "How thick, then, is the ship's side?"

"Oh," said he, laughing, "about an eighth of an inch;" and before I could quite grasp how much an eighth of an inch of steel really is in thickness, he had disappeared down a ladder at my feet.

"Come down here," he said, looking up and smiling at my evident blank dismay at his last piece of information. "This is the mess-deck for the blue-jackets—under the turtle-backed forecastle, you see."

One long table stood in the center, and two rows of lockers ran along the ship's side. A few men were down here, one stitching canvas, another mending his clothes, one reading a book, another writing a letter, and one stretched out right forward fast asleep, utterly oblivious of everything going on beside him.

"About twenty men live down here," said the "sub." "These are their hammocks, and that is the capstan engine—we have a steam-capstan."

He pointed above his head as he spoke.

"More store-rooms under our feet, too," he continued. "We keep the explosive war-heads for the torpedoes down below here. We have two eighteen-inch torpedoes carried, without the heads, in the tubes themselves. Now let us go up on the fore-bridge."

I followed him up the little iron ladders till beside the twelve-pounder, alongside which my old chum was standing, a chart in one hand and a pair of binoculars in the other; and when I reached the top I drew a long breath.

We had increased speed, and now we were well out of the Medway, and gliding along through the water so smoothly that I could hardly believe the statement that our speed was over twenty-four miles an hour. Slipping through the water with no vibration at all, the only indications of speed were the ripples on the water flying past us, and the fountain of spray rising at our sharp, straight stem, sparkling with all the colors of the rainbow as the sun's rays flashed upon it.

Far astern is the Nore light-vessel, clearly showing up on the horizon; a little ahead is the Mouse light-ships, round which we are going.

A beautiful blue sky above, with hardly a cloud to be seen, except that on one part of the horizon there is a little haze, which does not altogether cover a number of sailing-ships, vainly trying with the little wind there is to make headway against the tide. The fountain at the bows is playing beautifully now, and all around is the pure, bright sea-air blowing against one's face, and through one's clothes, and into one's body; rousing, stimulating and reviving one, and making one feel a new man, so refreshing and exhilarating it is.

Oh! that time was splendid, and I felt glad to be alive to experience such a sensation.

No wonder these fellows look so healthy with such a tonic, and living such a life as this.

"Starboard!" sings out my friend. "Starboard, sir," answers the quartermaster, whose head I, being startled in my reverie, nearly tread on, it having come up suddenly through a hole in the platform on which we are standing.

"Well, how do you like it?" queries my chum. "'Midships; steady." "Steady, sir," replies the head.

"I wish I were in your place," said I. "You have made a new man of me already."

"Oh," replied he, laughing, "come out on a cold, wet night in January, when a heavy sea is running, and you have to hang on to the rails or the twelve-pounder here to prevent yourself being carried off your feet; when the seas rise dashing on the turtle-back, and washing all over the upper-deck; when you are soaked to the skin, and, clinging on to something, are shivering and thinking of the many thousands ashore who are fast asleep, warm and snugly tucked between the blankets; when the blinding spray and sleet is lashing your face like whipcord in an incessant shower, so that you can hardly open your eyes as you vainly struggle to peer into the darkness to discern the lights of the vessel ahead; and when everything down below in the ward-room is sliding about on the deck, gloriously mixed up, so that if you wish to get a piece of meat for supper you have to hold the joint with one hand whilst you hack off a slice with the knife, and when you can't stand up by yourself—you'd soon change your mind."

Walking aft, we went down the engine-room ladder.

"I'm sorry we are only going 280 revolutions per minute now," says he. "You should see them going at 350. That's the time."

But even as it is, I wonder mightily to see these two engines with their many bright rods flashing up and down at a speed I can hardly make my hand move at; and the cranks whirring round at the rate of four revolutions per second are alone enough to make one pause and wonder when human ingenuity will reach its limit, and also speculate on what a terrible smash there would be if anything chanced to go wrong.

"Lunch!" yells the matter-of-fact "sub" down the hatch, and again are my musings rudely interrupted.

"We'll just have time for 'scran' before we get in," he says, as we all sit down round the little table in the ward-room. "The skipper is going to have his afterwards. Aren't you hungry? I am."

To which question I had to confess a mild "Yes, very." To tell the truth, I have ever since been envious of the appetite I had that day. But to continue.

Chaffing and joking formed the conversation whilst plates were being emptied and refilled, for every one seems to be put in a good temper by this sort of work. Millionaires should buy a destroyer, and try the life as a recipe for dyspepsia.

As to the messing, I must say it was far better than I imagined could obtain on board a small boat like this.

Plain but good and substantial food, excellently cooked, is the order of the day; and cut and come again is the order of the table; which last I carried out in spirit and in truth. A knock at the door. "Come in," shouts the "sub."

"Just going into harbor, sir. Captain sent me down to tell the officers," says the signalman.

Up the others jump. I follow, and reach the deck just in time to hear the telegraph gongs sound in the engine-room as the indicators are put to "slow."

We pass up close under the stern of the battleship "Sans Pareil," the guardship here, and very shortly after reach our buoy; and then I noticed that the smartness and agility which was the peculiar characteristic of the British bluejackets in olden times has not yet passed away, for a hand is down over the side and on the buoy in a twinkling, a hook-rope is hooked on, the cable passed down by the aid of a small rope, and then quickly shackled on to the buoy, and the bluejacket is up the side and inboard, whilst the cable is paid out under the direction of the gunner on the forecastle.

I hear the dingey called away, and turning round with the "sub," who has been explaining the proceedings to me, and going aft, I find my chum in mufti waiting to take me off. As for his lunch, he will get that ashore, he says; so "chin-chins" are passed, and, stepping over the side and down the ladder, we are quickly pulled beachwards, after a day's outing which was full of novelty to me, and which will not be forgotten for some time to come.

While cruising in a fog on the night of May 28, the U. S. S. Columbia was run into by the British freight steamer Foscolia, which tore a long hole in the starboard side of the warship. There was a dense fog at the time and though both vessels were sounding their whistles neither could locate the other. The "Columbia" is said to have carried no lights, a war-time precaution. The collision occurred about eight miles southwest of Fire Island light. The bow of the "Foscolia" was crushed in, and she soon filled and sank. A large hole was made in the "Columbia's" side, aft, about the waterline, but as her watertight doors had been closed she was able to proceed with only a slight list to starboard. No lives were lost. The cruiser docked at the Navy Yard in Brooklyn, where repairs were made, and she is now at sea

A collision attended with loss of life occurred between the North German Lloyd liner Ems and the Nova Scotia three-masted schooner Gypsum Princess, on the evening of June 14. The "Ems" was westbound, and when about twenty-five miles east of Nantucket, running slow in a dense fog, she cut down the sailing vessel, which immediately sank, carrying down the captain, his wife and two children, and two of his crew. The schooner was laden with about 1,100 tons of rock plaster, consigned to Staten Island parties. The lookout on the steamer did not sight the schooner until the "Ems" was in speaking distance, too late to avoid the disaster

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—X.

BY WM. BAXTER, JR.

Multipolar machines can be made in an almost infinite number of forms, just as is the case with those of the two pole type. Any construction that will admit of placing the poles so that their polarity will alternate around the circle will meet the requirements; but while the variety of designs can be increased indefinitely, the great majority will be found to be defective in one way or another, so that the actual number of desirable forms is not so numerous. Of all the types that have been brought forward only a few have survived, and of these the one most generally used is that shown diagramatically in Fig. 49. The ring F together with the projections N S which form the magnet cores as well as the pole pieces, forms the field proper of the machine. This may be cast integral with the base B or may be entirely independent of it. Whether the field F and the base are made in one piece or not

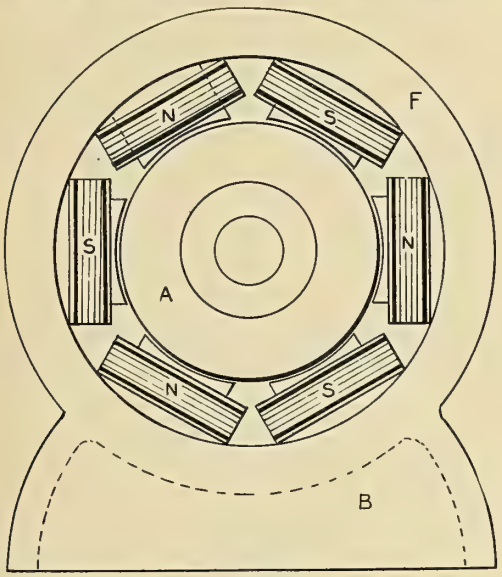


FIG. 49.

depends, in most cases, upon the facilities of the manufacturer for handling heavy work. If the tools and hoisting apparatus are small the separate construction will be followed; but occasionally this course is pursued so that the same machine may be made to run direct connected to a steam engine, or as a belted generator. If it is to be of the direct type, it is mounted directly upon an extension of the engine bed, and if it is to be of the belted type, it is placed upon the bed B, this being provided with suitable bearings to carry the shaft. These bearings, as well as the commutator and other parts, are not shown in the figure, nor in any of those that follow it, as the object of these illustrations is simply to show the relative position of the field magnets and the armature, which latter is indicated by the circle A. By comparing this figure with the two and four pole diagrams of the last article it will be seen that the construction is decidedly more massive, and preserves the compact appearance characteristic of the two pole machine.

The type of machine shown in Fig. 50, is simply an inversion of that in Fig. 49, that is, the field magnets are placed within the armature instead of outside of it. The ring A represents the armature, and the center part marked F serves the same purpose as the ring F in Fig. 49. It forms the connecting yoke between the ends of the magnet cores. In machines of this kind the base B and the part F are generally cast in one piece, except when the size is very great. When used in direct connection with a steam engine, the armature A may take the place of the fly wheel, the center F being secured to the engine bed. An objection to this design is that the armature is not protected from injury as well as in the opposite type shown in Fig. 49. In the latter the armature is within the field, and therefore if any object should fall upon the machine it would not be very likely to do any harm, whereas with the exposed armature it might work serious injury.

In both these designs it is necessary to have as many field coils as there are magnetic circuits. In some cases the number is reduced to one-half those shown in the figures, that is, three for a six pole machine, four for an eight pole, etc., but this instead of being a gain is a loss, as when one coil is used for each circuit, instead of two, the number of turns of wire in it must be equal to those in the two coils it replaces; and as on this account the outer layers of the coils become longer the total length of wire is actually increased. It is possible, however, to so

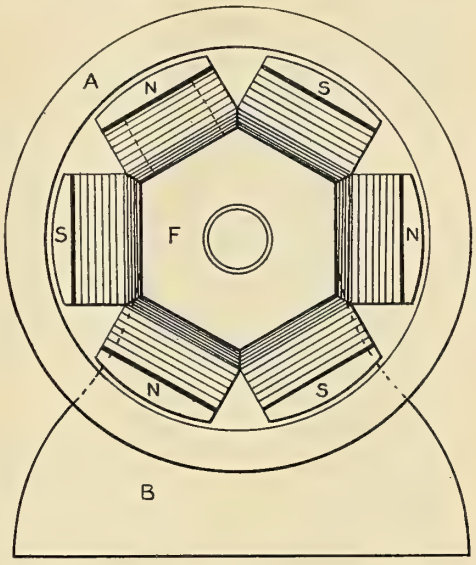


FIG. 50.

construct a machine that one coil will serve to magnetize the whole field, and when this is done the total length of wire can be considerably reduced. A design of this type is shown in Fig. 51 and 52. The first figure is a front view, and the second a half section parallel with the shaft. The magnetizing coil is shown at C, and the field magnets at N S. As can be seen from Fig. 52, the poles N of the part that passes in front of the coil C extend over the top of the latter to the oposite side of the armature A. In the same way the S poles extend forward over the coil. The part carrying the N poles is made separate from the hub F as can be seen in Fig. 52. If this were not done it would be impossible to get the coil C in place. In the section of the armature ring shown in Fig. 52, the wire is not shown, or rather wire and core are sectioned alike. It is to be understood, however, that the armature is covered with wire, but is not so shown, as it would only serve to confuse the diagram. The armature A is fastened to the shaft S by a spider which would be located on the side of the N poles.

This machine, like that shown in Fig. 50, has the field inside of the armature, but the order can be reversed so as to correspond with Fig. 49. This latter

construction is not often followed as it would largely, if not entirely defeat the object of the design, which is to reduce the amount of wire in the field coils by using only one. When the field is placed within the armature, this coil can be made of comparatively small diameter, as can be seen from the diagram; but if the armature is placed in the center, then the

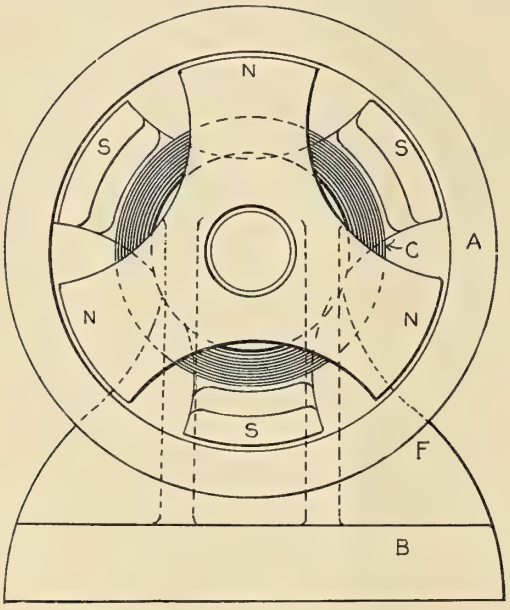


Fig. 51.

coil will have to be very much larger, and consequently the length of each turn of wire will be so much greater than the turns of coils, such as are required for the designs Figs. 49 and 50, that it will be sufficient to offset the difference in number of turns, and possibly more than offset it. Unless a considerable saving in wire can be effected by this design it is not worth using, as it cannot be made as symmetrical as Fig. 49. With the field inside the armature, as shown in the diagram, the saving in wire is sufficient to render the construction desirable, and in this form it is used to a limited extent.

Figs. 53 and 54 are a side and an end view of a design which is well adapted to cases where it is desired to reduce the width of the machine. The poles as will be noticed are placed around the outside of the armature, just as in Fig. 49, but the coils instead

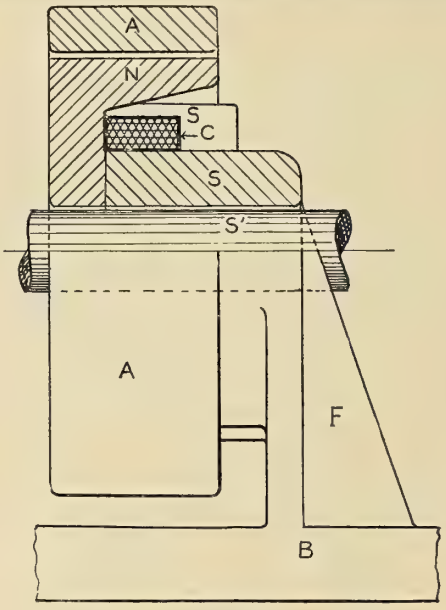


Fig. 52.

of being in the radial position, are at one side of the armature with their axis parallel with the shaft. The connecting yoke F instead of being a ring is a flat disc.

The width of this machine from outside to outside of the magnet coils is much less, relative to the

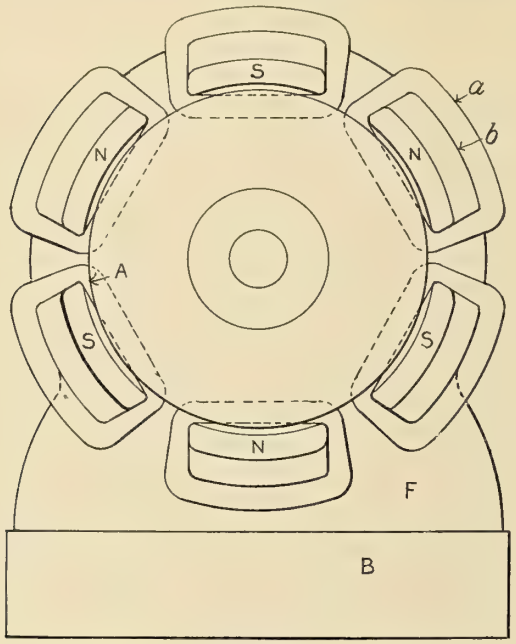


Fig. 53.

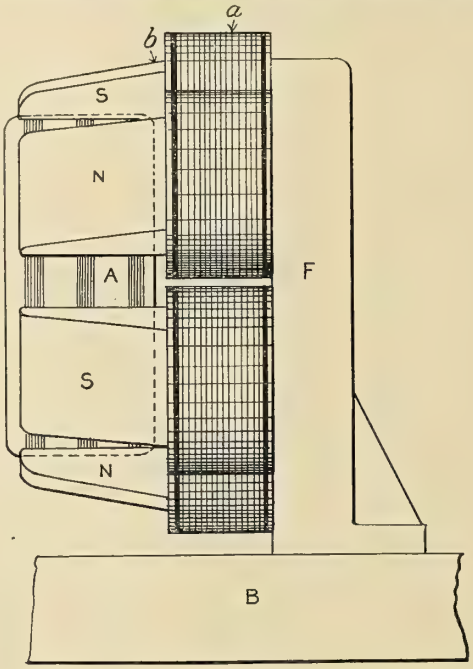


Fig. 54.

diameter of the armature, than is the case in the design Fig. 49, as can be seen from a comparison of two figures, hence, it is well adapted to cases where room in a direction transverse to the shaft is limited,

as for example where the machine is placed in a narrow passage way, or where there is very little head room. It might appear that Figs. 50 and 51 would be still more advantageous in this respect, as the field is wholly within the armature, but with these designs, it is necessary to make the armature extra large to secure sufficient room within it for the field magnets, so that for a given capacity its transverse dimension is little if any less than that of Fig. 49.

Fig. 51 is also made with the poles coming from one side as in Fig. 54, but in most such modifications the N poles are placed around the outside of the armature, and the S poles inside. This arrangement simplifies the construction, and considerably reduces the length of the machine.

The best known machine of type Fig. 50 is the Siemens and Halske. Type Fig. 51 is made by the Sturtevant Co., and type Fig. 53 by the C. & C. Co.

In summing up the merits of these different designs it may be said that, as with the two pole machines, the shape has very little to do with the efficiency, this depending almost entirely upon the relative proportions of the various parts, therefore a skilful designer can produce just as good results with one type as with another, and in making a selection will be guided principally by the conditions to be fulfilled.

ENGINEERS' DICTIONARY—VII.

Bolt.—In general a round rod or bar of metal provided with a *head* at one end and fitted with a *screw-thread* and corresponding *nut* at the other. This gives the typical *through-bolt*, Fig. 14. In some cases the bolt is threaded at both ends, or if short is threaded

U. S. OR SELLERS' SYSTEM OF SCREW-THREADS.

BOLTS AND THREADS.						HEX. NUTS AND HEADS.					
Diam. of Bolt.	Threads per Inch.	Diam. of Root of Thread.	Width of Flat.	Area of Bolt Body in Sq. Inches.	Area at Root of Thread in Sq. Inches.	Short Diam., Rough.	Short Diam., Finish.	Long Diam., Rough.	Thickness, Rough.	Thickness, Finish.	Long Diam. Sq. Nuts, Rough.
Ins.		Ins.	Ins.			Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
1/4	20	.185	.0062	.049	.027	1/2	7-16	37-64	1/4	3-16	7-10
5-16	18	.240	.0074	.077	.045	19-32	17-32	11-16	5-16	1/4	10-12
3/8	16	.294	.0078	.110	.068	11-16	5/8	51-64	3/8	5-16	63-64
7-16	14	.344	.0089	.150	.093	25-32	23-32	9-10	7-16	3/8	1 7-64
1/2	13	.400	.0096	.196	.126	7/8	13-16	1	1/2	7-16	1 15-64
9-16	12	.454	.0104	.249	.162	31-32	29-32	1 1/8	9-16	1/2	1 23-64
5/8	11	.507	.0113	.307	.202	1 1-16	1	1 7-32	5/8	9-16	1 1/2
3/4	10	.620	.0125	.442	.302	1 1/4	1 3-16	1 7-16	3/4	11-16	1 49-64
7/8	9	.731	.0138	.601	.420	1 7-16	1 3/8	1 21-32	7/8	13-16	2 1-32
1	8	.837	.0156	.785	.550	1 5/8	1 9-16	1 7/8	1	15-16	2 19-64
1 1/8	7	.940	.0178	.994	.694	1 13-16	1 3/4	2 3-32	1 1/8	1 1-16	2 9-16
1 1/4	7	1.065	.0178	1.227	.893	2	1 15-16	2 5-1-	1 1/4	1 3-16	2 53-64
1 3/8	6	1.160	.0208	1.485	1.057	2 3-16	2 1/8	2 17-32	1 3/8	1 5-16	3 3-32
1 1/2	6	1.284	.0208	1.767	1.295	2 3/8	2 5-16	2 3/4	1 1/2	1 7-16	3 23-64
1 5/8	5 1/2	1.389	.0227	2.074	1.515	2 9-16	2 1/2	2 31-32	1 5/8	1 9-16	3 5/8
1 3/4	5	1.491	.0250	2.405	1.746	2 3/4	2 11-16	3 3-16	1 3/4	1 11-16	3 57-64
1 7/8	5	1.616	.0250	2.761	2.051	2 15-16	2 7/8	3 13-32	1 7/8	1 13-16	4 5-32
2	4 1/2	1.712	.0277	3.142	2.302	3 1/8	3 1-16	3 5/8	2	1 15-16	4 27-64
2 1/4	4 1/2	1.962	.0277	3.976	3.023	3 1/2	3 7-16	4 1-16	2 1/4	2 3-16	4 61-64
2 1/2	4	2.176	.0312	4.909	3.719	3 7/8	3 13-16	4 1/2	2 1/2	2 7-16	5 31-64
2 3/4	4	2.426	.0312	5.940	4.620	4 1/4	4 3-16	4 29-32	2 3/4	2 11-16	6
3	3 1/2	2.629	.0357	7.069	5.428	4 5/8	4 9- 6	5 3/4	3	2 15-16	6 17-32
3 1/4	3 1/2	2.879	.0357	8.296	6.510	5	4 15-16	5 13-16	3 1/4	3 3-16	7 1-16
3 1/2	3 1/4	3.100	.0384	9.621	7.548	5 3/8	5 5-16	6 7-64	3 1/2	3 7-16	7 39-64
3 3/4	3	3.317	.0413	11.045	8.641	5 1/4	5 11-16	6 21-32	3 3/4	3 11-16	8 1/8
4	3	3.567	.0413	12.566	9.963	6 1/8	6 1-16	7 3-32	4	3 15-16	8 41-64
4 1/4	2 7/8	3.798	.0435	14.186	11.329	6 3/8	6 7-16	7 9-16	4 1/4	4 3-16	9 3 16
4 1/2	2 3/4	4.028	.0454	15.904	12.753	6 7/8	6 13-16	7 31-32	4 1/2	4 7-16	9 3/4
4 3/4	2 5/8	4.256	.0476	17.721	14.226	7 1/4	7 3-16	8 13-32	4 3/4	4 11-16	10 1/4
5	2 1/2	4.480	.0500	19.635	15.763	7 5/8	7 9-16	8 27-32	5	4 15-16	10 49-64
5 1/4	2 1/2	4.730	.0500	21.648	17.572	8	7 15-16	9 9-32	5 1/4	5 3-16	11 23-64
5 1/2	2 3/8	4.953	.0526	23.758	19.267	8 3/8	8 5-16	9 23-32	5 1/2	5 7-16	11 7/8
5 3/4	2 3/8	5.203	.0526	25.967	21.262	8 3/4	8 11-16	10 5-32	5 3/4	5 11-16	12 3/8
6	2 1/4	5.423	.0555	28.274	23.098	9 1/8	9 1-16	10 19-32	6	5 15-16	12 15-16

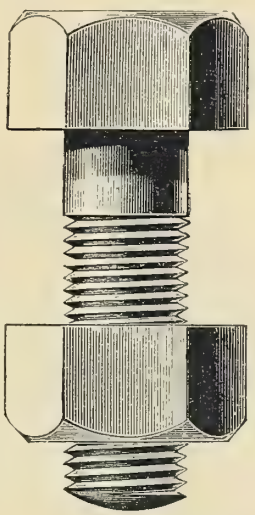


Fig. 14.

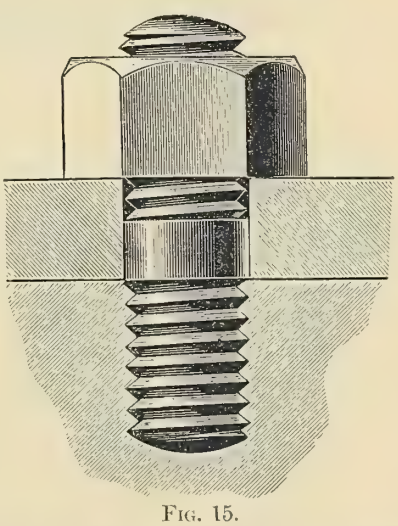


Fig. 15.

along its entire length, and the head is replaced by a nut. The *stud-bolt*, Fig. 15, is threaded at both ends, one end screwing into one of the portions of metal to be connected, and the other portion being provided with a hole corresponding to the body of the bolt. Such bolts are used for securing cylinder heads to the cylinders, valve chest covers to their chests, follower rings to their pistons, etc. The *cap-bolt* or *cap-screw* is a headed bolt without a nut. This form of bolt is much used for securing together two or more pieces where one of them may be readily tapped and thus made to serve as a nut, or where the use of a regular through-bolt with nut is not thought necessary.

Holding down bolts are those used to secure a structure or machine to its foundation. In particular this term refers to the bolts used to secure the engine bed-plate to its foundation. An *eye-bolt*, as shown in Fig. 16, is a bolt temporarily screwed into a convenient hole, say in a cylinder cover, and used to attach lifting and handling gear. A *forcing bolt* or *jack screw* is any form of bolt used to force apart two pieces as in breaking the joint between the cylinder head and cylinder. In such case the hole for the forcing bolt is tapped through the head only, and the bolt is screwed down through and against the cylinder flange. This results in forcing the two apart. For *stay bolt* or *screw stay* see *boiler*. In the following table will be found the U. S. standard proportions for bolts and nuts:

For the *locking* of bolts and nuts, various devices are used. Under continuous jar, screwed connections are liable to gradually work loose and thus nuts

might come off or stud bolts come out, and serious damage result. A very common form of lock is the double or jam-nut arrangement shown in Fig. 17. One nut being screwed down hard against the other, the surfaces of the nut and bolt become forced together in opposite directions in the two nuts, and thus no matter what the jar or change in the bolt, the two sets of surfaces continue to be firmly forced together, and no opportunity of working loose is presented. Another very common form is the *split-pin*, as shown in Fig. 18. A hole is drilled through the bolt just over the nut and a pin formed of a piece of soft steel wire bent on itself is inserted. The ends are then opened out and the nut is securely locked. The split-pin, however, cannot prevent the nut from backing off slightly, and the amount of possible movement will become greater as wear occurs and the nut is screwed further down. This can be compensated for by the use of a washer between pin and nut, but in any case the split-pin must be considered as a lock against the loss of the nut rather than against the slight loosening. A modification securing the nut against even

Fig. 16.

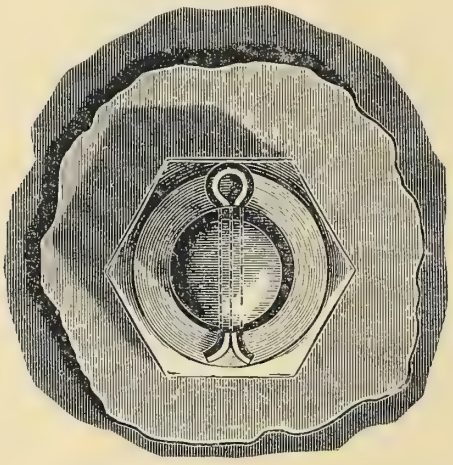


Fig. 18.

an initial loosening is frequently fitted. To this end scores or grooves are cut in the top of the nut, and the hole in the bolt is so placed that the pin rests partly in the these scores. These being several in number the pin can be inserted in any one of a corresponding number of positions of the nut. This form of lock is absolute and perfectly reliable, but is evidently of use only in cases where little or no wear and readjustment is expected. Nuts are often secured by set-screws in various ways. In some cases the set-screw bears directly on the thread, but this is not good practice, as the thread is likely to be injured and the removal of the nut is rendered difficult. In other cases a plug with screw thread or of soft metal is inserted to bear on the thread of the bolt, and is forced down by a set-screw. In other cases the upper part of the bolt is turned down clear of the thread and the set-screw bears on this portion. In other cases, where the form of the pieces allows, the nut is secured by a set-screw bearing on a part of the nut turned down and entering a recess or counterbore formed in the piece on which it bears, as shown in Fig. 19. In other forms, locking plates or strips are used. In Fig. 20 a plate fitting the nut is secured to the piece on which the latter rests, and this prevents the nut from turning. The plate, as shown, is so notched as to fit the nut in any one of twelve positions. In Fig. 21 the plate is fitted with a slot in such way that the plate and nut can be fitted in any position of the latter. In all cases where set screws are thus used, it will be noted that unless some means of locking them is provided, they may work loose and thus allow the main locking device to become inoperative or worthless. Set screws are often locked by a slight deformation or jamming of their thread by means of punch or chisel. This being effected at the point where the screw enters its thread, the unscrewing due to jarring may be prevented,

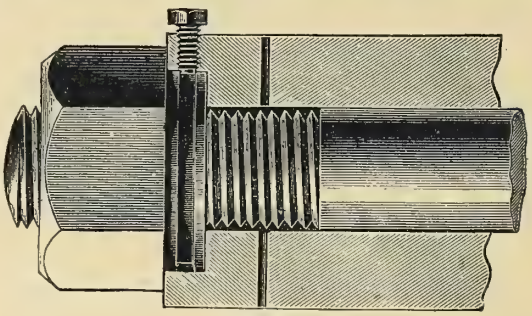


Fig. 19.

while the jamming is not sufficient to prevent removal by means of a wrench. This, of course, is bad engineering. By a slightly different arrangement of the elements of Fig. 21, the locking may be made complete instead of dependent upon a second screw. The screw in this case is in the form of a stud-bolt with square body fitting the slot in the plate. Above this is a thread upon which is screwed the nut which holds the plate in place. This nut is in turn secured by a plit-pin. Thus the plate locks the large nut, the stud-bolt and small nut secure the plate, the square body and slot lock the stud-bolt, and the pin locks the small nut. All screwed fastenings on marine engines, especially those on the moving parts, should be fitted with some efficient form of locking device. This is more necessary than in land practice where

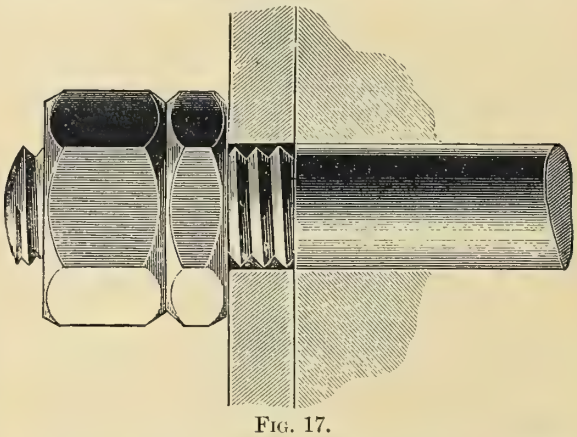


Fig. 17.

engines are usually shut down every day, allowing opportunity for inspection of parts, while in marine practice continuous runs of a month or more are frequent.

At the annual meeting of the Maritime Association of the Port of New York, President Hugh Kelly reported that the organization at the beginning of the year had 1,125 members and at the close 1,097; nineteen members had died during the year 1897.

QUERIES AND ANSWERS.

Q.—Please give a method for determining the sizes of the cylinders for a quadruple expansion engine, the steam pressure being, say, 200 lbs. per sq. in. Also, what you would consider the best points of cut-off for the different cylinders. STUDENT.

A.—For convenience we may divide the work up into a series of steps as follows:

(1) Assume the total number of expansions which the engine is to give. This is usually from 8 to 12 for triple expansion engines, and 10 to 15 for quadruple expansion. Within these limits, the greater the number of expansions the more economical will the engine be in coal consumption, but at the same

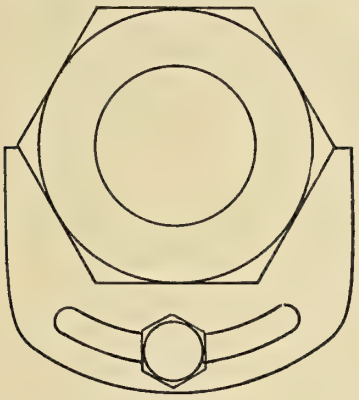


FIG. 21.

time the larger and heavier will it result. The number of total expansions selected will therefore depend on the relative importance placed on economy in coal consumption and economy in weight and space occupied.

(2) Find the absolute pressure at the high pressure valve chest by adding 15 lbs. to the gauge pressure at this point, making due allowance for the drop in pressure between boiler and engine. Then multiply this absolute pressure by the factor a in Table I below.

(3) From this result, which is an ideal mean forward pressure, subtract the assumed mean back pressure in the low pressure cylinder, which may usually be taken at from 3 to 4 lbs.

(4) If there were no loss between the ideal and the actual this would be the mean effective pressure, assuming all the

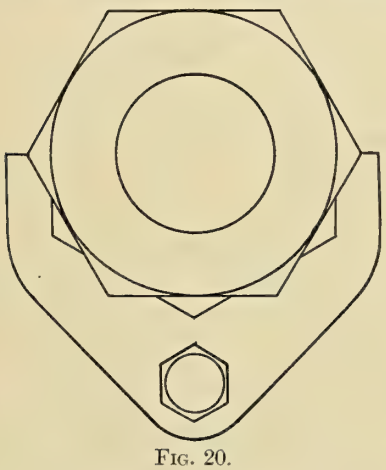


FIG. 20.

expansion to take place in a single cylinder. Assume next a card factor; that is, a factor which is intended to express the fraction of this ideal which is obtained in the actual case. This factor is usually about .60 to .70 with triple expansion engines, and a little less, perhaps from .55 to .65, with quadruple expansion. Multiply the result in (3) by this factor and call the product p. This result p is the probable or expected mean effective pressure reduced to the L. P. piston, and it should be remembered that it is at this point that the design is connected with actual experience.

(5) Next select a piston speed at which it is desired to run. This may vary from 500 to 1,000 feet per minute or upward, depending on the special conditions. Any limitations affecting the number of revolutions may also affect this speed. At this point, however, a trial value must be taken, and the design carried through on this basis. Denote the value assumed by S, and the I. H. P. by H.

Then substitute the known values in the formula:

$$A = \frac{33000\ H}{p\ S}$$

The result A will be the area of the L. P. cylinder in square inches. We may also denote these operations by rule as follows:

RULE: Multiply the I. H. P. by 33,000, and the pressure p as determined in (4) by the piston speed assumed. Then divide the former product by the latter. The result will be the area of the L. P. cylinder in square inches.

(6) Select from Table I the area ratios corresponding to the total number of expansions, and divide the area found in (5) by them. The results will give appropriate areas for the other cylinders, assuming a cut-off of about .60 in the H. P. cyl-

TABLE I.*

Total Number of Expansions.	Factor a.	Triple Expansion. $\frac{A_3}{A_2}$	Triple Expansion. $\frac{A_3}{A_1}$	Quadruple Expansion. $\frac{A_4}{A_3}$	Quadruple Expansion. $\frac{A_4}{A_2}$	Quadruple Expansion. $\frac{A_4}{A_1}$
7	.421	2.19	4.38	1.71	2.81	4.38
8	.385	2.35	5.00	1.80	3.07	5.00
9	.355	2.49	5.63	1.87	3.32	5.63
10	.330	2.62	6.25	1.93	3.56	6.25
11	.309	2.75	6.88	2.00	3.79	6.88
12	.290	2.88	7.50	2.06	4.02	7.50
13	.274	2.99	8.13	2.11	4.24	8.13
14	.260	3.11	8.75	2.16	4.46	8.75
15	.247	3.21	9.38	2.22	4.66	9.38

inder. This may be taken as an appropriate point of cut-off for the H. P. cylinder with the usual form of marine valve gear. For the remaining cylinders the cut-off is usually a little later, say from .65 to .75. It will be remembered that the cut-off on these remaining cylinders exercises no direct effect on the *amount* of power developed. It affects simply its distribution among the cylinders.

The areas of the cylinders being thus determined, their diameters follow immediately, most conveniently from a hand book giving diameters and areas of circles. The length of stroke may then be taken, usually not far from two-thirds the L. P. diameter, or frequently about the same as the I. P. diameter in a triple expansion engine. The stroke being taken, the revolutions follow immediately by dividing the assumed piston speed by twice the stroke in feet, or in symbols:

$$N = S \div 2\ L.$$

Examples:

(1) For a triple expansion engine of 1,000 I. H. P., take steam at the engine at 175 lbs. gauge, or 190 lbs. absolute. Assume 10 for the total number of expansions.

Then from the table, $a = .33$

Then $.33 \times 190 = 62.7$

Take back pressure $= 3.$

Remainder $= 59.7$

Take card factor $= .65$

Then reduced mean effective pressure $= 59.7 \times .65 = 38.8$

Take piston speed $= 800.$

$$\text{Then } A_3 = \frac{33000 \times 1000}{38.8 \times 800} = 1063$$

Then from Table I $A_2 = 1063 \div 2.62 = 406$

and $A_1 = 1063 \div 6.25 = 170$

Then finding the diameters, we have the following:

$D_3 = 36\ 3\text{-}4$

$D_2 = 22\ 3\text{-}4$

$D_1 = 14\ 3\text{-}4$

A suitable stroke would be either 21 in. or 24 in. This would give for the revolutions per mt.:

$$N = \frac{800}{3.5} \text{ or } \frac{800}{4}$$

or $N = 229$ or 200

(2) For a quadruple expansion engine of 1,000 I. H. P., take steam at the engine at 200 lbs. gauge, or 215 lbs. absolute. Assume 12 for the total number of expansions. Then from the table, $a = .29$.

Then $.29 \times 215 = 62.35$

Take back pressure $= 3.00$

Remainder $= 59.35$

Take card factor $= .58$

Then reduced mean effective pressure $= 59.35 \times .58 = 34.4.$

Take piston speed $= 800$

*Note.—A_1, A_2, A_3 denote the areas of the cylinders of a triple expansion engine, beginning with the H. P. Similarly, A_1, A_2, A_3, A_4, denote the areas of the cylinders of a quadruple expansion engine.

$$\text{Then } A_4 = \frac{33000 \times 1000}{34.4 \times 800} = 1199$$

Then from Table I $A_3 = 1199 \div 2.06 = 582$
$A_2 = 1199 \div 4.02 = 298$
$A_1 = 1199 \div 7.50 = 160$

The corresponding diameters are:

D_4	=	39
D_3	=	27 1-4
D_2	=	19 1-2
D_1	=	14 1-2

The stroke might be taken about 24 in. or 2 ft., which would give, correspondingly, revolutions about 200 per mt.

Q.—What is the formula for determining the thickness of a cast steel dished piston, that is now mostly used in marine engines that have lately been built?

S.

A.—The thickness of dished steel pistons for triple and quadruple expansion engines may be computed by means of the following formulae. These formulae are empirical in their nature. That is, they are so constructed as to relate the thickness of the pistons to the quantities on which they should depend, and the numerical portions are then determined from experience, so that, finally, the formulae are to be considered simply as convenient ways of expressing the results of safe and standard practice. For the various cylinders we have then as follows for the thickness near the boss:

$$T_H = .22\sqrt{\frac{H\,\overline{D}}{S}} + .30 \qquad (1)$$

$$T_I = .22\sqrt{\frac{H\,\overline{D}}{S}} + .50 \qquad (2)$$

$$T_L = .18\sqrt{\frac{H\,\overline{D}}{S}} + .70 \qquad (3)$$

Where the letters have the following significance:

T_H, T_I, and T_L = thickness near boss, respectively, of the high, intermediate and low pressure pistons.
H = indicated horse power to be developed in the given cylinder.
D = diameter of the given cylinder in inches.
S = piston speed in feet per mt.

For the thickness near the edge we may use the following proportions:

H. P. Thickness near edge = .65 thickness near boss.
I. P. " " " = .60 " " "
L. P. " " " = .55 " " "

For quadruple expansion engines the thickness of both intermediate cylinders may be determined by the use of formula (2).

Example: Let I. H. P. of engine = 1,600.

Let the cylinders be 20 in., 31 in. and 49 in. by 36 in. stroke, and let the revolutions be 125 per mt. Then S = 750. Then assuming the power about equally divided between the cylinders, we have in each case H = 533.

Hence:

$$T_H = .22\sqrt{\frac{533}{750} \times 20} + .3 = .83 + .30 = 1.13 \text{ or } 1\tfrac{1}{8} \text{ in.}$$

$$T_I = .20\sqrt{\frac{533}{750} \times 31} + .5 = .94 + .50 = 1.44 \text{ or } 1\tfrac{7}{16} \text{ in.}$$

$$T_L = .18\sqrt{\frac{533}{750} \times 49} + .7 = 1.06 + .70 = 1.76 \text{ or } 1\tfrac{3}{4} \text{ in.}$$

For the thickness near the edge we should have respectively: 3-4 in., 7-8 in. and 1 in.

Q. How do you go to work to set the blades on a ship with twin screws? I know how to do it with one screw, but the two wheels bother me. Where do you take your line for the angle?

J. W. B.

A.—The method of adjusting the blades of the propellers for twin screws is in every way similar to that for a single screw. The principle to be borne in mind is that each propeller is referred to its own shaft, and the plane with reference to which the pitch is set is in each case at right angles to the shaft axis. Hence with shafts diverging, as is usually the case, these reference planes are not exactly transverse or at right angles to the keel line. It results that the real pitch relative to the direction of motion is not quite equal to that for which the blades are set, but varies during a revolution slightly above and below this as a mean value. The variation, however, is not large, and is usually neglected in considering the pitch of the propellers.

As other readers may be interested in this general question, a brief description of the method of adjusting propeller blades is added. The principles involved are precisely the same as for measuring the pitch of a propeller as described in Marine Engineering for March, p. 36, and to which reference should be made. Fig. 1 is here reproduced from that account and will serve to illustrate the present answer, though in the case there assumed the blades for convenience were taken as fixed. The screw being in position on the shaft the arms P Q and P R which determine a reference plane at right angles to the shaft axis may be provided most conveniently by an arm and hub of wood fitted to the projecting end of the shaft, the nut being removed for the purpose. The wooden hub should be made in two parts with provision for clamping so that it may be fixed in any desired position, and it may be well to bush it with sheet metal in order to prevent its following the threads. It should be faced and fitted snugly up to the after face of the propeller hub so that when it is turned around there will be no fore and aft motion. A stiff wooden arm carried on the hub then completes the apparatus and serves,

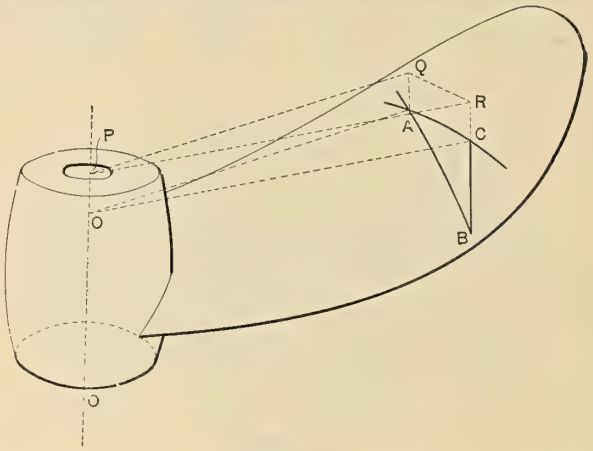


FIG. 1.

as it is turned about the shaft, to determine a reference plane or edge from which the necessary measurements can be made.

In proceeding with the adjustment a blade may be set by judgment and the resulting pitch measured. The setting may then be corrected until by successive trials the pitch is brought to the desired value. If the propeller is a true screw or of uniform pitch for some one adjustment, it will no longer remain so when the blades are twisted, and measurements at different distances from the hub will give slightly different values for the pitch. If measurements are not made at more than one location, it should be at about two-thirds the length of the blade from the hub. If the mean of two sets of measurements is taken, they may be located at about the middle of the blade and at about three-quarters the length from the hub. We may determine more rapidly the adjustment corresponding to any given value of the pitch at any given location as follows. Referring to the drawing we have, as explained in the March number, the following proportion:

A C : $6.2832 \times$ O A :: B C : pitch;

$$\text{or B C} = \frac{\text{A C} \times \text{pitch}}{6.2832 \times \text{O A}};$$

$$\text{or B C} = \frac{\text{pitch} \times \sqrt{\overline{\text{A B}}^2 - \overline{\text{B C}}^2}}{6.2832 \times \text{O A}}$$

From this we find on solving for B C,

$$\text{B C} = \frac{\text{pitch} \times \text{A B}}{\sqrt{(\text{pitch})^2 + 39.48\ \overline{\text{O A}}^2}}$$

This gives by formula the difference B C between the distances R B and Q A from the reference line to the surface of the blade at the given points A and B. These operations may be expressed by a rule as follows:

(1) Take the given radius as O A in the diagram.
(2) Select two points at this radius as A and B and measure A B.
(3) Multiply the desired pitch by the distance A B.
(4) Add the square of the pitch and 39.48 times the square of O A and take the square root of the sum.
(5) Divide the product obtained in (3) by this square root and the quotient will be the distance B C suitable for the desired pitch at this radius. The blade must then be so adjusted as to make the measurement B C conform to this value.

According to reports in the press there is a prospect that another shipyard will be established at Portland, Ore., by Chicago capitalists. The site said to have been selected has a depth at low water of about 26 ft. at the launching ways.

The Cleveland Ship Building Co., is reported to have secured a contract for a new steamer for the Northern Steamship Co., in dimensions about 400 ft. long, 50 ft. beam, and 28 ft. deep, to cost in the neighborhood of $240,000.

OBITUARY.

Niven C. Mehan died at Rockland, Me., June 12, from a stroke of apoplexy. He learned the shipbuilding art in New England, and in the early fifties was established in Rockland. Later he came to New York to the yard of William H. Webb, and thereafter was associated with Charles Payson at Thomaston, and Samuel Watts at Boston.

Thomas Mudd, an eminent English engineer, died at his residence in Hartlepool, May 17. He was managing director of the Central Engine Works at West Hartlepool, where he designed and built the famous machinery equipment of the freight steamer "Inchmona," described in our issue of February last. Deceased was a member of various British engineering societies and had been prominent in municipal affairs, having been twice mayor of Hartlepool.

John F. Pankhurst, vice-president and general manager of the Globe Iron Works Co., died in Cleveland June 2. This was his native city, he having been born there in 1838. When a lad at school he decided upon marine engineering as his life work and pursued studies with this in view and later served his apprenticeship as a machinist. When this was completed he spent some time as an engineer on the lakes. In 1865 he went into business with Mr. Wallace, and later the Globe Iron Works was taken over by the concern. In 1886 the works ownership was reorganized and incorporated with a capital stock of half a million dollars. In this corporation Mr. Pankhurst was given the position he held until his death.

Samuel Plimsoll, universally known in shipping circles as the "sailors' friend," died in England early last month, aged 74 years. Every British vessel carries a reminder of his great sympathy for those exposed to the perils of the sea, in the load waterline or Plimsoll mark painted on the side. He was a native of Bristol and from his earliest days took an active interest in shipping affairs. Finding that he could do more for the sailor in the British Parliament than outside he contested the Derby seat in the Liberal interest in 1868, and for many years thereafter was a familiar figure in the House of Commons. He met with tremendous opposition, but his exposure of the rascally doings of British shipowners, some of whom were in Parliament at the time, compelled the passage of laws which did away with the "floating coffins"—vessels in rotten condition, overloaded with cargo and insurance, and undermanned, which left port and never returned.

Dr. Charles E. Emery died of heart disease at his residence, 370 Gates avenue, Brooklyn, June 1. He was born in Aurora, N. Y., in 1838, and in 1861 he entered the navy and was commissioned third assistant engineer of the "Richmond," seeing a good deal of active service before the close of the war. In 1867 he retired from the navy and became consulting engineer for the U. S. Coast Survey and Revenue Service. Later he occupied himself almost exclusively with engineering matters on land, including the installation of the system of the New York Steam Company. He retained, however, an active interest in marine construction and was regularly at the meetings of the Society of Naval Architects and Marine Engineers, of which he was a member. Several of the leading technical societies bear his name on their rolls. Dr. Emery's reputation was international, he having, among other achievements, secured the Telford prize from the British Institution of Civil Engineers for an original paper. Due to his large frame he was always a noticeable figure at scientific gatherings, and his genial personality will long be pleasantly remembered by a large circle of friends. He leaves a widow and one son.

BOOK NOTICES.

"Practical Advice for Marine Engineers," by Charles W. Roberts, M.I.M.E., is contained in a 150-page book published by Whittaker & Co., Paternoster square, London. It is entirely practical in character, giving hints on matters about which questions arise every day in the engine room. There are six chapters entitled: The Engineer; In the Stokehold; The Donkey Boiler; In the Engine Room; Down the Tunnel, and The Propeller. Many easily understandable engravings are used where they do the most good, and altogether it is an excellent little work. The selling price is 2s 6d a copy.

The Scientific American Special Naval Supplement recently issued includes a brief history of the navy between the years 1883-1898, with the authorizations up to date. The method of classifying the various types of war vessels is explained and a full description is given of all the principle war vessels under the following main heads: Battleships, Cruisers, Monitors, Gunboats, Torpedo Boats, etc. Valuable tables of statistics are also given, and a colored map of Cuba. The number is filled with fine engravings of vessels of the Navy, and the text is written in a very readable and popular style. Copies can be had by mailing 25 cents to the publishers, Munn & Co., 361 Broadway, New York.

"Refrigerating Machinery, its Principles and Management," is the title of a little book received from the author, A. Ritchie Leask, of London, England, which is a practical treatise on the subject. It was written to cover the methods of refrigeration now in vogue rather than to explain any special application of the systems ashore or afloat. It is of convenient size and covers the subject very concisely and clearly, though, of course, from a British standpoint of view. The introductory chapter is chiefly historical, but also states clearly the laws of physics involved in the construction of such machines. This is carried in the next chapter into a discussion of the various systems of producing ice. Then follow in order, chapters on ammonia and cold air machines, comparisons of the different systems and their applications, and lastly a chapter of practical hints upon the operation and regulation of machines and consideration of questions of efficiency and cost. The book is a convenient size for desk use and contains a large number of excellent illustrations. The American agents for this work are Spon & Chamberlain, 12 Cortlandt street, New York.

"Naval Engineers and the Command of the Sea," by Francis G. Burton, which appeared in serial form in the Practical Engineer, England, has been reprinted in book form by the Technical Publishing Co., 31 Whitworth street, Manchester. This book is really 230 pages of glorification of the British Navy with corresponding disparagement of other navies including the French and United States. The title is scholarly, the book anemious. Instead of concentrating interest upon a logical discussion of the subject the author wearies his reader with interminable discussions of side issues. To make these palatable he works in a lot of narrative about imaginary sea fights in which the French fleet finally meets with disaster, in a war with that nation, and the United States having turned pirate is equally subdued. "There was much tall talk in Washington of a dash on Canada," says the author, "whilst the drinking saloons of New York, Chicago and Baltimore were rife with suggestions for the destruction of the British power, but no concerted military or naval movements resulted therefrom." It will be noticed how lightly he skips over Philadelphia, but then probably he believes the Quaker city has no saloons. "Without warning," according to Mr. Burton, the Irish-American pirates

"bombarded Belfast," using shells filled with Greek fire, and sleeping women and helpless children were blown to pieces in their beds or burned to death before they could escape. Thus in that generous and delicate mode of thought and expression for which English writers are renowned, when dealing with the deeds of other nations, Mr. Burton narrates the destruction of Belfast. It is really surprising that in this day of newspapers and cables any reputable publisher could be found to put such blatherskite between covers—probably the author guaranteed expenses. The price of this remarkable work is 2s 6d, but we do not predict for it an extensive sale here.

Beeson's Marine Directory for 1898, just published, makes the eleventh annual edition of this useful work. The new volume contains a number of pages more than the previous issue, in which the following matters, among others, are classified: List of American Steam and Sailing Vessels on the Lakes, giving chief characteristics; Record of Engines and Boilers of Lake Vessels; List of Vessel Owners; Pilot Rules; Minute Descriptions of American Lake Ports, alphabetically arranged; Classified Directory of Manufacturers and Dealers, besides much data of a nautical, commercial, and legal character. Typographically the book is an excellent production, and the pages are enlivened by many very interesting engravings. Harvey C. Beeson, 308 Royal Insurance Building, Chicago, Ill., is the proprietor and publisher, and the cost of the work is $5.00.

TRADE PUBLICATIONS.

The catalogue received from the New Haven Mfg. Co., New Haven, Conn., illustrates a line of lathes, planers, shapers and a good many other tools such as are used in shipyards and other engineering establishments. The catalogue comprises several pages and is very fully illustrated, the pages being 6 in. by 9 in. in size.

A catalogue and price list of screw-cutting and other labor-saving tools is received from Wells Bros. & Co., Greenfield, Mass. The catalogue is compact in size and fully illustrated, describing a large line of cutters, screw plates, lathes, drills, and other devices of much value for use in machine shops, on board ship, or in shipyards.

A very attractive catalogue is issued by the L. S. Starrett Co., Athol, Mass., illustrative and descriptive of the fine mechanical tools and milling and other cutters manufactured by this company. It comprises over 100 pages and is very fully illustrated. Every user of fine tools would find one of these catalogues valuable for reference.

An illustrated catalogue and price list of high pressure valves and fittings, indicator devices, etc., has been issued by the Kennedy Valve Mfg. Co., 75 John street, New York. It is 7 in. by 10 in. in size, and contains 32 pages of matter well illustrated and neatly printed on coated paper. The index adds much to the value of the catalogue, as do also tables and dimensions and other valuable matter. Copies can be had upon application by mentioning Marine Engineering.

"Can I Become an Electrical Engineer?" is the title of a 64-page pamphlet 5 in. by 7 in. in size issued by the Electrical Engineer Institute of Correspondence Instruction, 120 Liberty street, New York. It is well printed and contains a good deal of information regarding the school which publishes it. It also contains excellent portraits of all leading electricians from the very earliest to the very latest. Any of our readers who have any desire to inform themselves on the subject of electricity should send for a copy of this book, referring to this notice.

Users of paint should have the sheet of sample colors issued by the U. S. Gutta Percha Paint Co., Providence, R. I. This paint is especially adapted for marine purposes as it is elastic and waterproof and is not affected by salt water.

A house organ called "Supplies" is issued by E. F. Houghton & Co., 240-250 West Somerset street, Philadelphia, Pa. It is devoted to the interests of the buyer and user of engine supplies and probably sample copies will be sent to any of our readers who wish them.

People interested in shallow draught boats should send to the Marine Iron Works, Station A, Chicago, for a picture of the "Fortune Hunter," which has just been built by this company for use in Alaska. Full information can be had upon application to the company.

A card is received from the William Powell Co., Cincinnati, Ohio, printed in four colors and illustrating the Powell Star Re-Grinding Valve. The card is 12 in. by 16 in. in size and is prepared for hanging up. In the center is a large picture of a valve printed in color to imitate the brass of which it is made.

Economy Drilling Compound, a lubricant designed especially for use on machine tools and elsewhere, is fully described in a catalogue just issued by the manufacturer, the White & Bagley Co., Worcester, Mass. The pamphlet contains an amount of information and a number of testimonials from users of this lubricant.

A valuable little book of 36 pages giving much information regarding the subject of patents has been issued by the Power Publishing Co., World Building, New York. Every person interested in patents or intending to take out one, whether in this country or in any other, should send for a copy in order to learn all about patents.

An unusually well printed little book 4 in. by 7 in. in size is received from De Grauw, Aymar & Co., 34 and 35 South street, New York, regarding the flags manufactured and sold by this company. The book is printed in several colors on tinted pages and gives a good many samples of flags, ensigns and a variety of colors manufactured by this company; also reproduction in color of the flags of the several nations.

A new catalogue has been issued by the Draper Machine Tool Co., Worcester, Mass. This company makes a specialty of screw-cutting and other lathes, planers, etc. This is a line of tools particularly adapted for use in shipyards, and also in machine shops on board large steamers. The catalogue is well printed, comprising over 50 pages 6 in. by 9 in. in size. It is bound in a neat cover of green with gold lettering.

Hub ball and roller bearings manufactured by the Ball Bearing Co., Watson street, Boston, Mass., are very well described in a 4 1-2 in. by 6 in. catalogue of 36 pages just received. Various types of bearing are fully illustrated and complete price lists are given. The "final word" in the catalogue should be noted by every reader who sends for a copy of this catalogue, and everybody who is interested in the subject of anti-friction bearings will want a copy.

The Van Norman "Duplex" milling machine manufactured by the Waltham Watch Tool Co., Springfield, Mass., is very fully illustrated and described in an eight-page folder just received. This machine has many important features. Among others the cutter head can be set in almost any position or at any angle, giving a very wide range of work. The smallest size machine could readily be used on board steam vessels, while any size would be a most useful tool in a machine shop.

The 1898 catalogue of L. W. Ferdinand & Co., 184 Federal street, Boston, Mass., is very complete as it contains 250 pages 6 in. by 9 in. in size. A string is attached for the purpose of convenience of hanging up. Almost everything that can be of any use to the builder and user of a boat or vessel is fully illustrated and described in these pages. Every one of our readers who has any need whatever for purchasing marine supplies can have a copy of this catalogue by mentioning Marine Engineering.

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

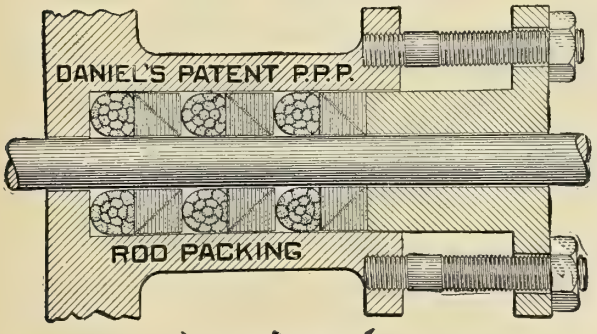
It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

Daniel's Patent P. P. P. Diagonal ROD PACKING

BRANCH OFFICES:
PITTSBURG, 105 Water St. CHICAGO, 4 S. Canal St.
SAN FRANCISCO, 514 Mission St. TOLEDO, 638 Leonard St.

The Most Elastic Packing. The Cheapest Packing. Less Friction on the Rod than any other. Wears the longest and gives the least trouble and the greatest satisfaction.



SEND FOR BOOKLET.

Have you seen Daniel's Patent Packing Gauge for Measuring and Cutting accurately Rod Packing, and given away?

Manufactured ONLY by...

C. A. DANIEL, 409 Market Street, PHILADELPHIA, PA.

BUSINESS NOTES.

A HANDSOME 40 FT. LAUNCH.—A handsome launch called the "Samoset," 40 ft. long and costing about $4,000, has just been put into service between the Battery and Ellis Island in New York Harbor. It was built by the Marine Vapor Engine Co., Jersey City, N. J., and has Alco-Vapor engines.

PAINT AND VARNISH REMOVER.—A new material is being put on the market by the Wilson Co., 11 Broadway, New York, which will be of much interest to marine people. It is a preparation which can be applied to a painted surface with a brush and which will remove all the paint or varnish to which it is applied.

ENGINE ROOM OUTFITS.—Two of the new Government torpedo boats building on the Pacific coast will have complete engine room outfits, supplied by the American Steam Gauge Co., 36 Chardon street, Boston, Mass. These outfits include gauges, valves, clocks, etc. The two boats are being built by Wolff & Zwicker, Portland, Ore.

VULCAN WRENCHES.—The wrenches advertised elsewhere by J. H. Williams & Co., 9-31 Richards street, Brooklyn, N. Y., are now being extensively used on a large number of merchant vessels as well as on many naval vessels. The name "Vulcan" as applied to this particular tool is a trademark which has been registered in the United States and in several European countries. Circulars regarding these wrenches are sent to all inquirers.

GARLOCK PACKINGS AND GASKETS.—The piston packings, gaskets, etc., manufactured by the Garlock Packing Co., Palmyra, N. Y., have always been known for their quality and excellence and are fortunate in having had a reputation for the past 18 years. This company has offices and agencies in several parts of the country, as shown by their advertisement, and sends all inquirers catalogues and other information regarding its goods.

EXPERIENCE 40 YEARS

MANUFACTURING

HAND POWER PUMPS— FREE AND FORCE. Yachts, Schooners, Ships, Barges, Scows (Deck and Bilge), Contractors' Trenches, Vaults, Cesspools, Manholes, Brick Yards, Mines, Irrigating, Tanneries, Weir Pole Driving, or for any duty where **Hand Power** is used.

WINCHES. Cargo, Chandelier, Derrick, Portable and Centerboard.

WINDLASSES. Gypsy and Pump Brake.

STEERING GEARS. Cape Catboats, Knockabouts, Sloops, Schooners, Ships, Launches and Steamboats.

RELIEF STEERING GEARS. Steam Yachts, Steamships.

CAPSTANS. Common and Power.

FANCY WOOD STEERING WHEELS. 19 inch to 72 inch.

BRASS WORK. Stanchions, Deck Plates and Gratings, Hood Ventilators.

MECHANICAL FOG HORNS. King (Lever), Edson (Crank).

Street Sweeping Machines. Automatic Bottle Fillers.

Send for Illustrated Catalogue.

EDSON MANUFACTURING CO.,

132 Commercial St., BOSTON, MASS.

ENGINEERS' SUPPLIES.—A hanger lithographed in colors is issued by Patterson, Gottfried & Hunter, 146-150 Centre street, New York, representing a man talking to an engineer. According to the text he is telling of the excellent quality of the supplies furnished by this firm.

THE AMERICAN STOKER.—Users of stokers will be interested in a catalogue issued by the American Stoker Co., Broadway and Liberty street, New York. This stoker works on the underfeed principle and is believed to be well adapted to marine work. We understand that some tests are about to be made to find the efficiency of this stoker on board ship. For stationary work it has already made a reputation.

"HOLDING ITS STEAM."—The recent test of steamer Clara attracted much attention among the guests on the trial trip because of the manner in which the boiler held its steam uniformly in a very rough sea. The boat rolled badly in the lower New York bay, but the water did not leave the gauge glass nor did the boiler siphon when the whistle was blown. No difficulty was encountered in getting under way for want of steam after a stop and although the boat bucked a strong tide for hours plenty of steam was always to be had. The boiler was a "Boyer" manufactured by the Boyer Patent Sectional Water Tube Boiler Co., 90 Wall street, New York.

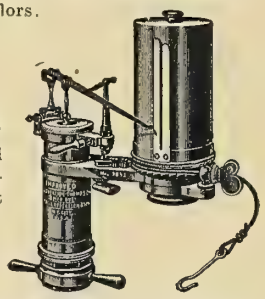
RUBBER AND ASBESTOS PACKING.—Following is a sample order received by A. W. Chesterton & Co., Boston, Mass., for their "Rubberbestos" sheet packing: "Messrs. A. W. Chesterton & Co.—Gentlemen—Please send me five yards 1-16 in. "Rubberbestos." I find this the best sheet packing for general use that I have ever used, and the only one that will stay in our steam traps for any length of time. Yours truly, W. H. Matteson, Chief Engineer, Homeopathic Hospital, Boston." From the success they are having with this new sheet packing it would seem that asbestos and rubber compounded in the manner it is used in "Rubberbestos" is a success.

SEND 2 LABELS

cut from front of boxes of EUREKA PACKING and we will send you a pack of beautiful playing cards. All being special in 3 colors.

MARINE ENGINEERS

should own an INDICATOR and know how to use it. Send for circular and *special* prices. It will interest you.



Jas. L. Robertson & Son,
218 Fulton St., N. Y.

REDUCING VALVES

to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.

THE YANKEE DRILL GRINDER,

For Grinding Both Twist and Flat Drills,

IS A MACHINE SHOP NECESSITY.

"Can't Grind Wrong."

This machine grinds all sized drills from ⅛ to 2¼ inches. Can be set for any size in a few seconds. Gives any desired clearance. Also grinds 3 lipped drills and chucking reamers.

We know we have the best and latest machine of the kind made.

WE GUARANTEE IT FULLY.

(Copy.)

G. T. EAMES CO., Kalamazoo, Mich. DODGE MANUFACTURING CO, Mishawaka, Ind., May 27th, 1898.

Gentlemen:—We have been intending for some time to write you in regard to the three Twist Drill Grinders which we purchased of you, and trust you will pardon the delay.

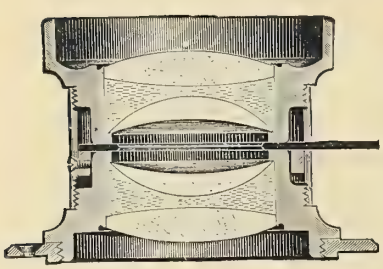
We are greatly pleased with these machines, and find them to be all and even more than your salesman represented. We find them very efficient for the purpose, and superior in many respects to machines which are sold for many times the price of yours upon the market. We are at a loss to know how we ever got along without them, and certainly wish you success in placing them before the trade ofthe country.

Yours truly,
DODGE MANUFACTURING CO., per M. W. MIX, Pres't.

SEND FOR PARTICULARS AND TESTIMONIALS OF USERS.

G. T. EAMES CO., 200 Michigan Avenue, Kalamazoo, Mich.

GOERZ DOUBLE ANASTIGMATIC LENSES



Cover sharply up to the circle of light, have great depth of focus and unequalled speed, and are therefore the only lenses which will satisfactorily photograph engine room interiors.

CATALOGUE FREE ON APPLICATION.

C. P. GOERZ,

52 Union Square, East, = = = = = = *New York,*

AND AT ALL DEALERS.

THE EMPIRE MARINE MOTOR.—The manufacturers of these motors, C. C. Riotte & Co., 1955 Park Ave., New York, have been rushed with orders this spring to supply the demand. They are made in sizes from one to twenty horse power and have several distinctive features, which are described in a circular issued by the company regarding them. This company also supplies launches and many auxiliary appliances.

NICKEL STEEL FOR BOILERS.—Every engineer will be interested in some tests of nickel steel which have been made by the Orford Copper Co., 37 Wall street, New York. Regarding three boilers built a recent letter from the company states: "When the first boiler was built, we could not convince the builders that it would be wise or safe to reduce the thickness of the steel, so it was built of the same weight as ordinary boilers. We then had two more built, and here the thickness of the shell was reduced about 1-8 in. We were unable to get tubes of nickel steel, so that in all three boilers the tubes were of ordinary steel. One boiler has now been built for nearly two years; the last two have been running since last November. After running a time the interior of the nickel steel boilers becomes perfectly smooth and almost glassy, therein differing, for some reason which we cannot explain, from ordinary boilers. We find there is a considerable saving of fuel in these boilers as compared with ordinary boilers working immediately alongside under exactly the same conditions. We are now having another boiler constructed with nickel steel tubes, which are to be made by the Shelby Tube Co., of Cleveland, Ohio."

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

A 75 FOOT STEAM YACHT FOR SALE.

A fine steam yacht 75 ft. long, 12 ft. 6 in. beam, equipped with Wells quadruple engines and water-tube boilers, surface condensers, circulating pumps, speed 18 miles an hour, is offered for sale. Is in prime condition in every respect and has carrying capacity of 75 passengers. For particulars address Steam Yacht, care Marine Engineering.

PROFESSIONAL CARD.

H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.

Manufacturer of **Screw Propellers** for Usual and for Special Work.

The Allen Dense Air Ice Machine for Steam Vessels.

41 MAIDEN LANE, NEW YORK.

PORTABLE FORGES.—The portable forges offered by the Crumlish Forge Co., 80 Virginia St., Buffalo, N. Y., are being much used not only in shipyards, but on board many vessels, because of the many valuable features. They are constructed of steel, weigh only 90 lbs., and occupy only 19 in. of deck space. Sheet steel bellows are an important feature. Many very complimentary testimonials are printed in a folder, which will be sent by the company to all who are interested in the subject.

PASTE, FOR ENGINEERS. NO ACID. NO GRIT. LIQUID, FOR YACHT BRASS, &c.

Only polish that will clean burnt oil and rust from iron and steel.

Polishes all metals.

STAR METAL POLISH.

Gives high polish to brass, nickel, &c., with very little labor.

The best for yachts, &c.

For Samples, &c., address **J. P. COLE, 80 Cortlandt St., N. Y.**

The Mabbs Hydraulic Packing.

USED ON FASTEST ATLANTIC LINERS.

This packing has no equal for Propellers, Stern Pipes, Water Works, Deep Mine Pumps, Ice Machines and all machinery using cold water.

It is the most pliable and durable Hydraulic Packing in the market. *It can be worn entirely out, simply by adding new packing when required, and not disturbing the old.* It will never cut a rod or cylinder, on account of the nature of the material, it being always a good lubricant in itself.

MABBS HYDRAULIC PACKING COMPANY,

BOX 829, CHICAGO.

Telegraphic Address: Mabbs, Board of Trade Bldg.

IMPERIAL METAL POLISH.

IMPERIAL
METAL
POLISH.
EASILY APPLIED.
RADIANT IN LUSTRE.
INSTANTANEOUS IN ACTION.
ALL METALS, HOT OR COLD.
LIQUID OR PASTE.

MADE BY

THE RATH MANUFACTURING CO.

New York—Philadelphia.

18 and 20 Liberty Street, NEW YORK CITY.

Hancock, Laurel & Second Sts., PHILA., PA.

NEW YORK OFFICE:

WILLIAM E. BURTON, Manager.

EXPORT DEP'T.

FREDERICK W. KRISTELLER.

Remember the name IMPERIAL.

W. P. PHILLIPS & CO.,

MANUFACTURERS OF

OIL CUPS,
LUBRICATORS,
GREASE CUPS

—AND—

ENGINEERS' SPECIALTIES,

No. 71 Sudbury St., BOSTON, MASS.

RAINBOW PACKING

Makes a Steam Joint Instantly.

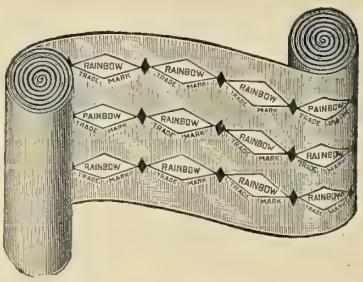
HONEST JOHN.

MR. JOHN H. DEMING.
General Superintendent Peerless Rubber Manufacturing Co.

THE COLOR OF RAINBOW IS RED.

NOT AFFECTED BY OILS, AMMONIA LIQUORS, STEAM HEAT OR ALKALIES.

None genuine without the Trade-Mark.



RAINBOW PACKING HAS 3 ROWS OF DIAMONDS IN BLACK EXTENDING THROUGHOUT THE ENTIRE LENGTH OF EACH AND EVERY ROLL.

Fac-simile of a Roll of Rainbow Packing.

Who invented and who is the only man in the world who can make or ever has made

Rainbow Packing.

RAINBOW GASKETS are especially adapted for Low Pressure Steam and Hot Water Heating Apparatus.

PEERLESS DISCS for Russell, Frink, Walworth, Jenkins, Lorain and Kelly & Jones Valves.

"HONEST JOHN."

Made in both Straight and Spiral Form.

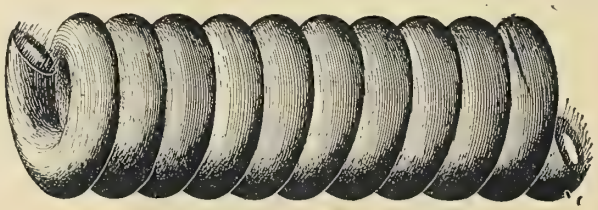
Once Tried, Always Used.

Put up in Boxes.

HYDRAULIC RAINBOW CORE PACKING.
The Best Hydraulic and Cold Water Packing in the World.

Hercules Combination.

Always Tight. Leaves the Stem Clean.



Will Hold 400 lbs. Steam.

Metallic Stop Valve Packing.

SEND FOR CATALOGUE.

Patented, Copyrighted and Manufactured Exclusively by

THE PEERLESS RUBBER MANUFACTURING CO.,

16 Warren Street, New York.

16-24 Woodward Ave., Detroit, Mich. 202-210 So. Water St., Chicago, Ill.
17-19 Beale St., and 18-24 Main St., San Francisco, California.

The Francis Tool

PATENTED MAY 25TH, 1897.

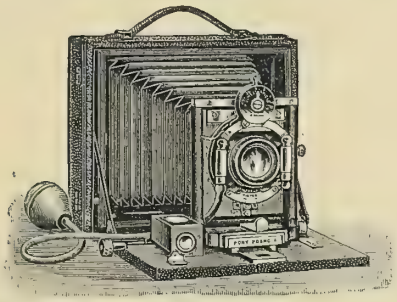
It has no Screws.
No Slipping.

Made of Wrought Steel.
Cutter Easily Removed.

Write for Prices, etc.

THE UNITED STATES METALLIC PACKING COMPANY,
SOLE AGENTS AND MANUFACTURERS,
429 NORTH 13th STREET, PHILADELPHIA, PA.

TO ENGINEERS



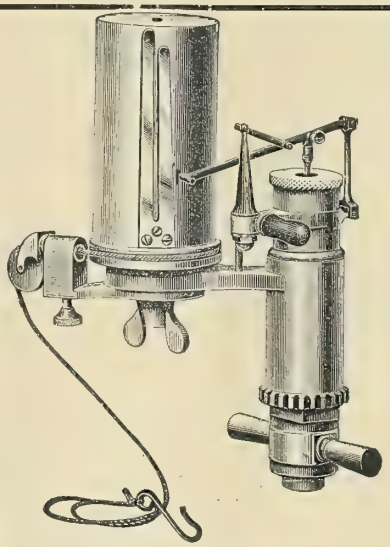
THE Premo Camera

Will be found valuable in making reports of the progress of work on a contract. A photograph conveys a more definite idea than the longest written description.

ALL STYLES. ALL SIZES.
$5.00 TO $50.00

Send Your Address for Illustrated Catalogue.

ROCHESTER OPTICAL CO., ROCHESTER, N. Y.



AMERICAN THOMPSON IMPROVED INDICATOR.

ORIGINAL THOMPSON INDICATOR.

Ideal Reducing Wheel, Pantograph and Planimeter.

BOURDON & LANE'S PRESSURE AND VACUUM GAUGES.

AMERICAN POP SAFETY VALVE.

AMERICAN STEAM GAUGE CO.,
34-36-38 Chardon St.,
Chicago BOSTON, MASS. New York
SEND FOR CATALOGUE F.

GREAT LAKES REGISTER.

COMBINED AND ISSUED IN CONNECTION WITH

BUREAU VERITAS.

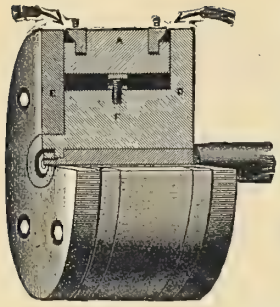
INTERNATIONAL REGISTER OF SHIPPING.

F. D. HERRIMAN, SURVEYOR GENERAL:
MAIN OFFICE: ROYAL INSURANCE BUILDING, CHICAGO, ILLS.

Now prepared to issue Certificates upon Wood and Metal Vessels, Supervising Construction, Etc.

GREAT LAKES REGISTER desires to announce that its ratings go before the leading underwriters of America, England, and France.

The services of its surveyors, who are located at all principal ports, may be engaged on Hulls and Cargoes.



SELF-ADJUSTING STEAM CYLINDER PACKING

for **STEAMSHIP, YACHT, TUGBOAT,** and all classes of **ENGINES,** high and low pressure. Makes piston perfectly tight with minimum of friction. Increases revolutions of wheel, saves fuel, secures true cylinder. Owing to its immediate action, engines can be started, stopped, or reversed instantly. Used in the engines of the leading Steam Yachts and Vessels.

We guarantee no leakage of Steam over piston.

Manufactured and licenses granted to manufacture under our patents by

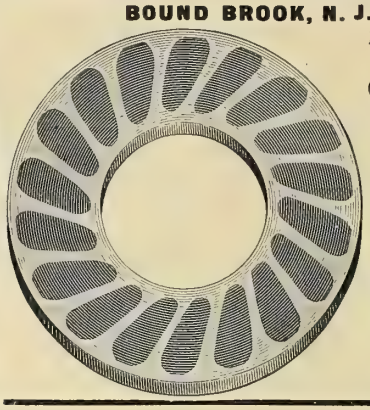
THE ST. JOHN CYLINDER PACKING CO.

General Offices: 108 Fulton Street, N. Y. City, N. Y.

SHELDON H. BASSETT, Gen'l Agt.

THE GRAPHITE LUBRICATING CO.,

BOUND BROOK, N. J., U. S. A.,



MANUFACTURERS OF PATENT

Graphite and Bronze

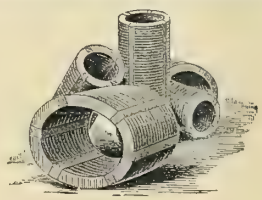
BUSHINGS, BEARINCS AND **WASHERS.**

For all kinds of

Machinery, Hoisting Apparatus, Tackle Blocks, Etc., Etc.

Can be used with or without Oil.

GASKETS.



ANY SIZE OR SHAPE, FOR THE SMALLEST HAND HOLE OR THE LARGEST CYLINDER TOP. : : : :

Our various grades of stock are adapted for any and all kinds of joints, and will give entire satisfaction under the highest pressures and most severe conditions.

BOSTON BELTING CO.

JAMES BENNETT FORSYTH,
Mfg. Agt. and Gen. Mgr.,
Manufacturers of

BELTING, HOSE, PACKING, VALVES AND RUBBER GOODS
of the Best Quality.

BOSTON: 256-260 Devonshire St.
NEW YORK: 100 Reade St.
BUFFALO: 90 Pearl St.
CHICAGO: 109 Madison St.
SAN FRANCISCO: 24 Fremont St.
NEW ORLEANS: 316-318 St. Charles St.

RANDOLPH BRANDT,

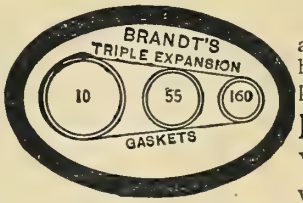
38 Cortlandt Street, New York.

SPECIALTIES.

SELDEN'S PATENT PACKINGS

are made either with a rubber core or a canvas core and will keep stuffing boxes tight with less friction than any other packing.

BRANDT'S TRIPLE EXPANSION GASKETS



are the best man-hole and hand-hole gaskets for high pressures.

BRANDT'S PUMP VALVES will stand hot water and oils.

The best grades of **Rubber Hose, Joint Packings** and other **Engineers' Stores.**

Orders filled promptly and satisfaction guaranteed. Your trade is solicited.

GARLOCK'S HIGH-GRADE PACKINGS

They are the **IDEAL** Packings for

Steam, Water, Gas, Ammonia, Etc.

The STANDARD for 18 YEARS, and hold the RECORD for QUALITY, DURABILITY and ECONOMY. Send for Samples and New Catalogue.

CUT GASKETS for Man-holes and Hand-holes.

Garlock's Gaskets and Rings.

Superior to all others. Our standard grades are the Garlock Gasket, the Economical Gasket, the Achilles Gasket. Engineers and dealers will find it to their interest to correspond with us as to prices, for we guarantee to save you money.

THE GARLOCK PACKING CO.

New York, Poston, Chicago, Philadelphia, Pittsburg, Cleveland, St. Louis, Denver.

Main Offices and Factories: PALMYRA, N. Y., ROME, GA.

"PHENOMENAL!"

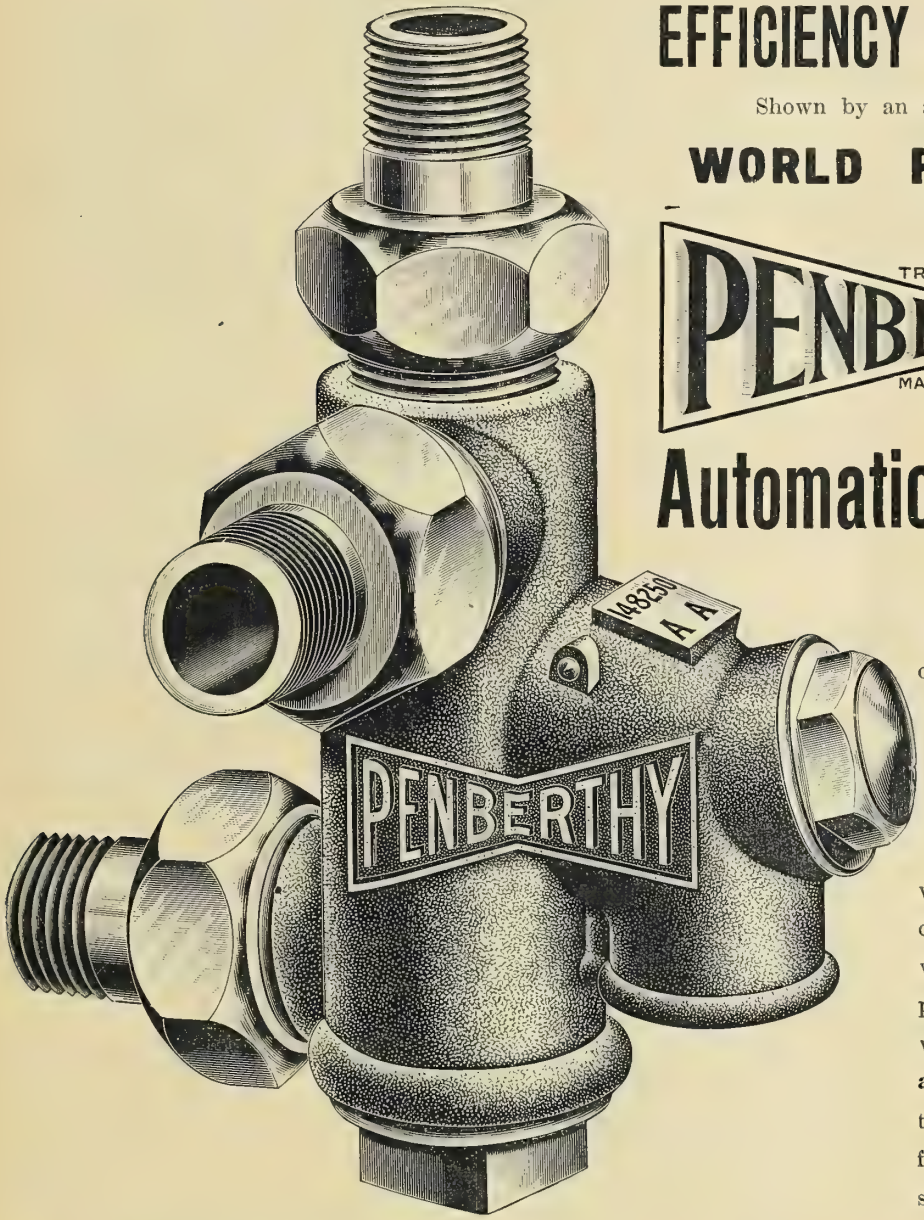
EFFICIENCY 99½ per cent.

Shown by an actual test of the

WORLD RENOWNED

TRADE **PENBERTHY** MARK.

Automatic Injector



Made by

Prof. M. E. COOLEY,

of the University of Michigan.

• •

WE QUOTE FROM HIS REPORT.

"The next Injector tested was a 'Penberthy,' a machine which not only worked most easily, being perfectly automatic within wide range, **but also with a high degree of economy,** the proportion of water forced to steam used rising steadily, the

EFFICIENCY OF 99½ PER CENT.

BEING A PHENOMENAL RESULT."

INSIST

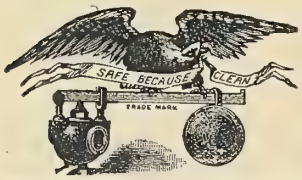
on having a genuine "Penberthy"

on your boat this season.

YOU CAN DEPEND UPON IT WHEN NEEDED.

PENBERTHY INJECTOR CO. 115 SEVENTH ST., DETROIT, MICH.

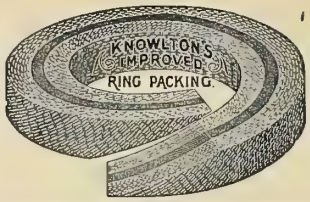
THOS. C. WARLEY & CO., *Manufacturers of*



BOILER CLEANSING COMPOUNDS

Main Office: No. 11 So Ninth St.,
P. O. Box 1262. Philadelphia, Pa.

These Compounds are unequalled. They give satisfaction where others fail. They are especially adapted for use in Marine Steam Plants. Write for Descriptive Circular.



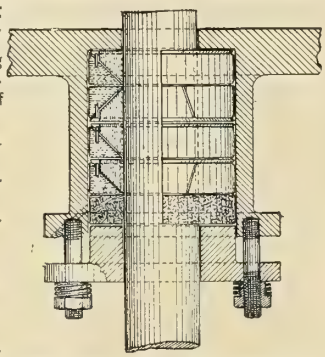
No Rubber on the Rod. A Cushion in the Right Place.

KNOWLTON PACKING CO.,
19 Pearl St., BOSTON, MASS.

KATZENSTEIN'S
METALLIC PACKINGS

Of different designs for stuffing boxes of engines, pumps, etc.

Flexible Tubular Metallic Packing for Slip Joints on Steam Pipes.
Metallic Gaskets for all kinds of Flanges.
Highest Grade Anti-Friction Meta. for Bearings.
Patent Automatic Life Boat Detacher.
Patent Duplex Water Tight Compartment Doors.

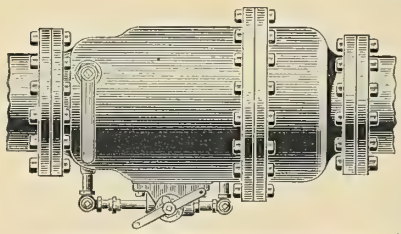


L. KATZENSTEIN & CO.,
General Machinists' and Engineers' Supplies, : :
357 WEST ST., NEW YORK, U. S. A.

Craig's Steam, Vacuum and Hydraulic Specialties,

Consisting of PATENT

IMPROVED SAFETY QUICK-ACTION AUTOMATIC STOP VALVES,



Improved Safety Quick-Action Stop Valve.

For Pipes of all kinds under Pressure, for Steam, Water or any other fluid.

IMPROVED AUTOMATIC EXHAUST RELIEF VALVES,
For Condensing and Non-condensing Engines, Marine or Stationary.

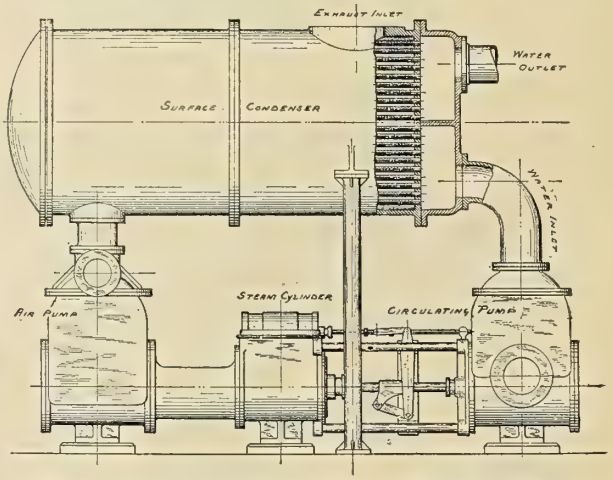
HEATING and CIRCULATING APPARATUS for STEAM BOILERS.

ADDRESS
WILLIAM CRAIG, 121 Liberty St., New York.

WAINWRIGHT
CORRUGATED TUBE
SURFACE CONDENSERS,

10 to 2,000 Square Feet of Surface.

No paper ferrules. No corset-lacing packing. Tubes fastened at each end with brass thimbles. Absolute freedom from leaky joints.



We also manufacture Feed Water Heaters, Expansion Joints, Corrugated Copper Gaskets, etc.

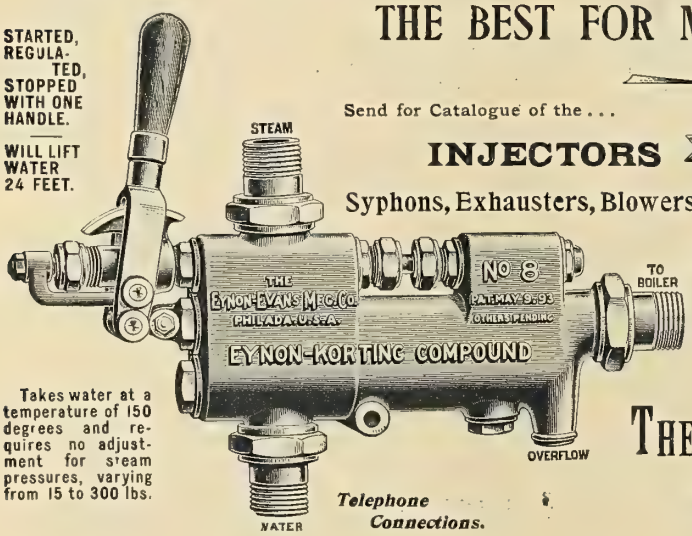
Taunton Locomotive Manufacturing Co.,
TAUNTON, MASS.

Eynon-Korting Compound Injector.

THE BEST FOR MARINE, LOCOMOTIVE
AND STATIONARY BOILERS.

STARTED, REGULATED, STOPPED WITH ONE HANDLE.

WILL LIFT WATER 24 FEET.



Takes water at a temperature of 150 degrees and requires no adjustment for steam pressures, varying from 15 to 300 lbs.

Telephone Connections.

Send for Catalogue of the . . .

INJECTORS **CONDENSERS**

Syphons, Exhausters, Blowers, Ventilators, Blast Nozzles, Bilge-Pumps, Etc.

BRONZE FOUNDRY DEPARTMENT:

Copper Castings, Phosphor and Manganese Bronze, Red and Yellow Brass Castings.
Capacity 10,000 lbs. per heat.

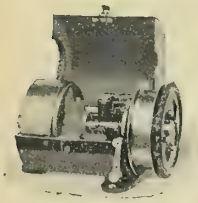
THE EYNON-EVANS MFG. CO.,
1513 Clearfield Street,
Philadelphia, Pa.

BY SIMPLY PRESSING A BUTTON YOU CAN

STOP YOUR ENGINE

Close any valve in your steam pipe.
Throw out a friction clutch.
Stop a wat r wheel.
Stop a gas or oil engine.
Stop anything controlled by valve or lever.

If your Engine Starts to Race or RUN AWAY
THE MONARCH SPEED LIMIT Stops It Automatically.



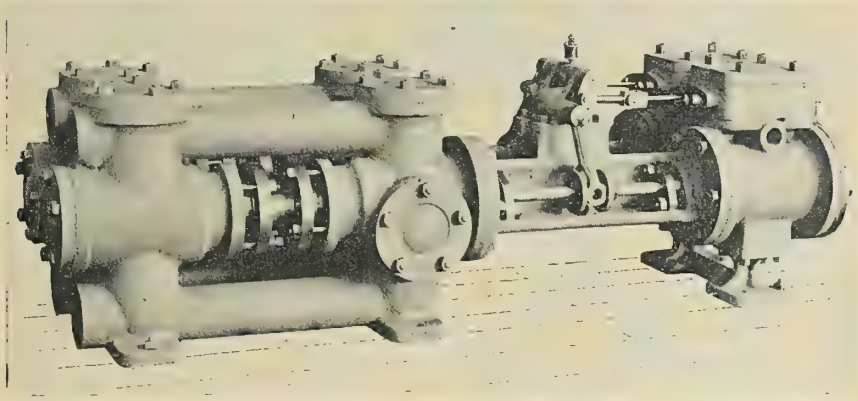
SHOULD YOUR

STEAM PIPE RUPTURE,

THE MONARCH STOP CLOSES THE BOILER STOP VALVE AUTOMATICALLY.

By placing press buttons in various positions about the ship, your engine or boiler valves can be closed almost instantly by touching any one of them.
Write for Illustrated Catalogue and Particulars,

THE MONARCH MFG. CO., 39 Cortlandt Street, NEW YORK.

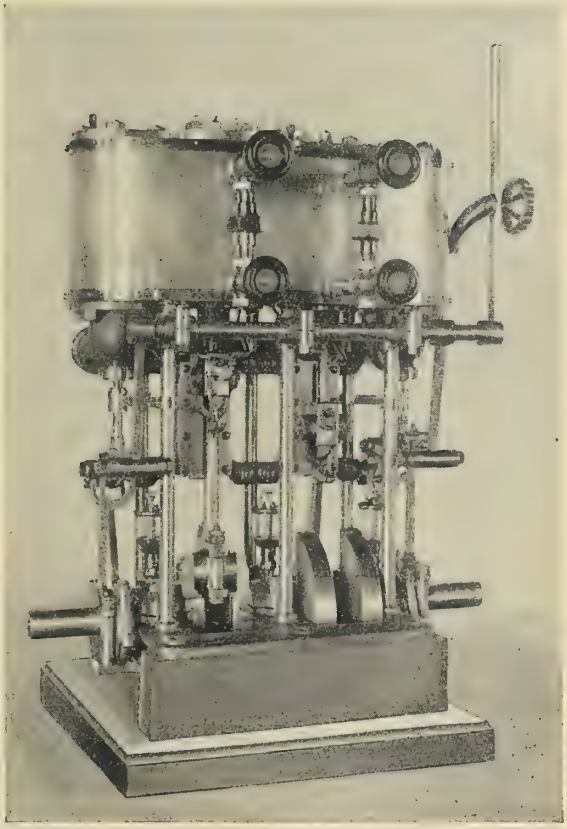


THE HUGHES IMPROVED DUPLEX PLUNGER PUMPS

Are extra strong, compact and durable. They are externally packed and are particularly well adapted for marine service. Catalogue showing different styles will be sent on application.

THE SNIDER-HUGHES CO., COE AND HAMILTON STREETS, CLEVELAND, O.

Yacht,
Blower
AND
Electric
Light
Engines



In Stock
OR
In Progress
AT
All Times
Compound
and Single.

W. D. FORBES & CO., Hoboken, N. J.

THE IMPROVED

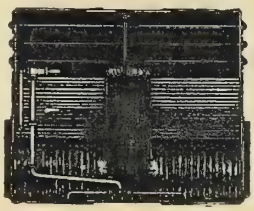
ANNULAR STEAM JET

Most Powerful and Economical Known. Equal to Fan Blower. In use on Sound Steamer of 4,000 horse power, 2—8 ft. stacks. Cut on right shows section of Jets which attach to spider as shown on left. We are prepared to fill orders for any size stack, promptly.

THE

EQUILIBRIUM CIRCULATOR

Circulates the Water in Steam Boilers. Increases Steaming Capacity. Equalizes Expansion. Prevents Foaming and Pitting. Prolongs Life of Boiler. Saves Cost of Repairs. Now in 55 Boilers.

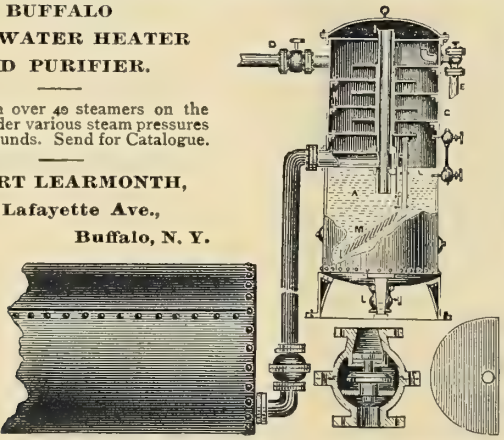


H. BLOOMSBURG & CO. NEWPORT NEWS, VA.

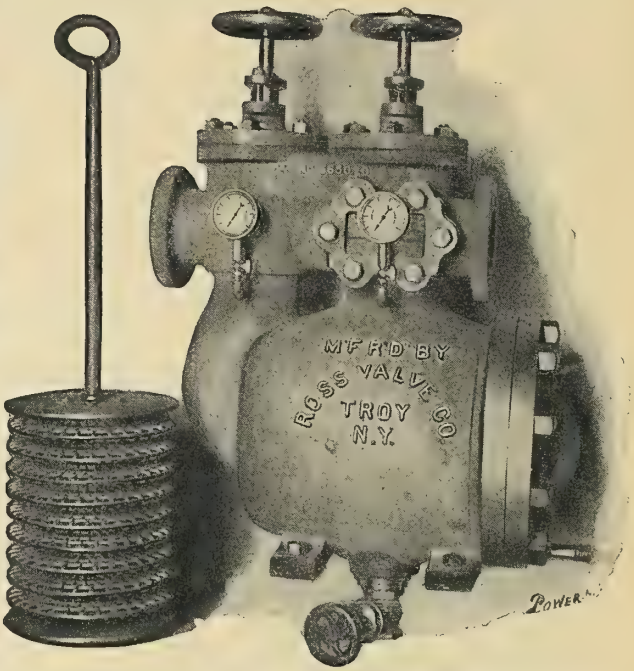
BUFFALO
FEED WATER HEATER
AND PURIFIER.

In use on over 40 steamers on the lakes. Under various steam pressures up to 250 pounds. Send for Catalogue.

ROBERT LEARMONTH,
200 Lafayette Ave.,
Buffalo, N. Y.



KEEP OIL OUT OF YOUR BOILER



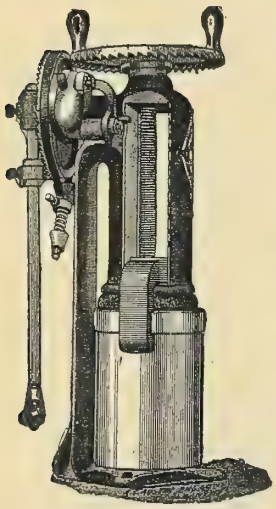
BY USING THE ROSS FEED WATER FILTER.

For all Particulars, Address

THE ROSS VALVE CO.,

TROY, N. Y.

National Automatic Lubricator, Patented.

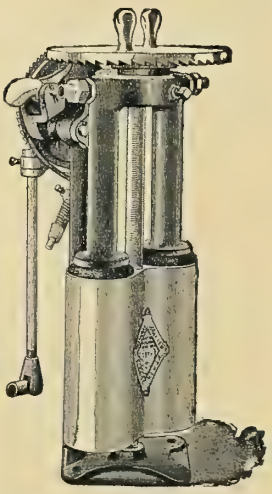


AN ABSOLUTE FORCED FEED.

Positive, Reliable,
Economical, Satisfactory.

Guaranteed to save 30 to 60 per cent of oil and give better results to frictional parts. Not affected by change of temperature or consistency of oil.

If you are thinking of getting a New Engine or Pump, specify this Lubricator. It will be money in your pocket.



WRITE FOR CATALOGUE OF LUBRICATORS AND SIGHT FEED ATTACHMENTS.

National Lubricator Co.,

BUFFALO,
SHERWOOD MFG. CO.

ALBANY, N. Y.

MAGNESIA SECTIONAL COVERING

The ONLY Genuine Magnesia. Others so-called are FRAUDULENT.

Over 85% Carb. of Magnesium

USED ON

Nine-tenths of the U.S. Government vessels.

More High-Class Yachts than All Other Coverings Combined.

All leading S. S. S. B., Towing and Dredging Lines, etc.

Send for References, Tests, Prices, etc., etc., to

3 TERRACE, BUFFALO. **ROBERT A. KEASBEY,** 83 WARREN STREET, NEW YORK.

THE PARAGON BOILER

These boilers are being adopted by Erie Canal steamboatmen. NO HIGHER ENDORSEMENT POSSIBLE, as Erie boatmen must use the most Efficient, Durable, and Economical Boilers made.

For Circulars and Information, Address

Capt. M. DE PUY, Patentee,

19 South Street, - - NEW YORK.

KINGSFORD BOILER WORKS, *OSWEGO, N. Y.*

Marine Boilers of every description designed and constructed on short notice. Estimates given.

Best Material.
High Class Workmanship.
Reasonable Prices.

Special Types of Marine Boilers for Steam Yachts, Passenger Steamers, and Tugs.

Kingsford Foundry and Machine Works,
OSWEGO, N. Y.

THE WATSON RADIAL WATER-TUBE BOILER

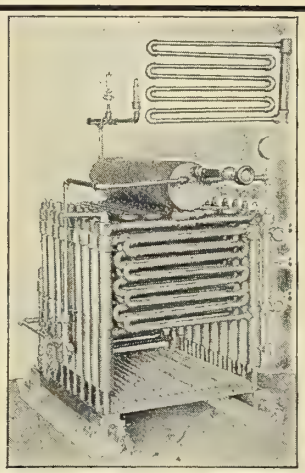
Lightest, cheapest and most practical in market; furious steamer; compact, wholly made of steel plate and tubes, no castings or bricks; any desired pressures up to 500 lbs. per square inch; sizes fully tested are 3 1-2 h. p., 10 h. p. and 20 h. p., but any size up to 225 h. p. simple engine (400 compound) will be made. Boilers made to order only; none allowed to be carried in stock for marine work. Performance guaranteed in every case or money returned. Send for illustrated catalogue to

ECBERT POMEROY WATSON,
ELIZABETH, N. J.

STONINGTON LINE.

The inside Route, especially safe and comfortable. Connects at Stonington with Express Trains for Boston, Providence, Worcester and all points North and East.

Leaves New York, Pier 36, N. R., daily except Sunday.



THE BUCKLEY PATENT

SAFETY WATER TUBE BOILER

FOR

Boats and Yachts.

No Left Hand Threads in this Boiler.

For Catalogue and Prices address

ROCHESTER MACHINE TOOL WORKS,
20 Frank Street,
ROCHESTER, N. Y.

ALMY WATER-TUBE BOILER CO.

MANUFACTURERS OF

Almy's Patent Sectional Water-Tube Boilers

For Marine and Stationary Work,

Nos. 178 TO 184 ALLENS AVENUE (between Rhodes and Public Streets),

TAKE EDDY ST. CAR.
LONG DISTANCE TELEPHONE.

Providence, R. I.

MARINE

ENGINES

Simple, Compound and Triple.

ALSO

FIRST-CLASS REPAIR WORK

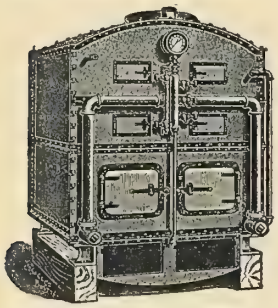
Promptly and Thoroughly Done.

CHARLES L. KING, BROOKLYN, N. Y.

Foot of 55th St.

CLARK'S PATENT SAFETY WATER TUBE BOILER.

For MARINE and STATIONARY WORK.



Now Used in a Number of Yachts, Launches and Passenger Steamers.

MANUFACTURED BY

EDWARD S. CLARK,

Nos. 272-278 Freeport St.,

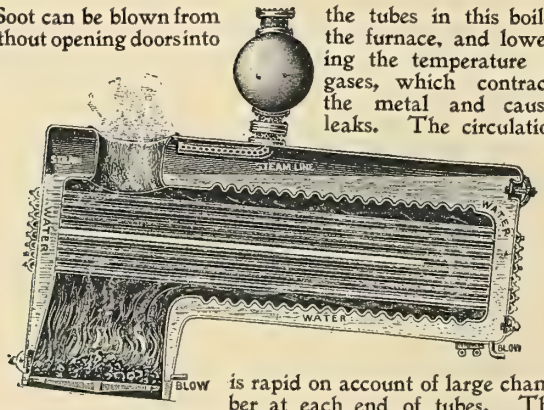
Harrison Sq., Boston, Mass.

THE TONKIN PATENT

INTERNALLY FIRED WATER-TUBE BOILER

For Marine or any Purpose where Steam is Required.

Soot can be blown from the tubes in this boiler without opening doors into the furnace, and lowering the temperature of gases, which contracts the metal and causes leaks. The circulation



Blow is rapid on account of large chamber at each end of tubes. The boilers are in use where water is very bad. Still, the tubes are kept clean by the rapid circulation.

Eight tests showed from 11.985 to 14.660 pounds of water evaporated per pound of combustible from and at 212° F. We can save money for you.

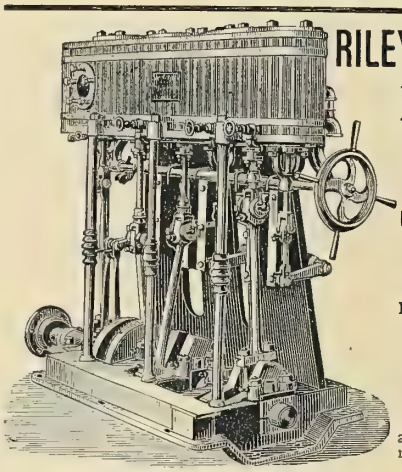
Adapted to any pressure up to 500 pounds.

JOHN EATON,
President Oil Well Supply Co.,
PITTSBURG, PA.

JOHN J. TONKIN,
Room 609, Havemeyer Bldg.
26 CORTLANDT ST., N. Y.

BRANCH OFFICES:

15 Federal Street, Boston, Mass., W. H. Bailey, Manager.
54 Manufacturers' Record Bldg., Baltimore, Md., John H. Buxton, Manager.



RILEY & COWLEY,

Machinists

—and—

Engineers,

Richards St., Cor. Bowne, South Brooklyn, N. Y.

Builders of Compound and Triple Expansion Engines for Steam Launches, Yachts and Tow Boats.

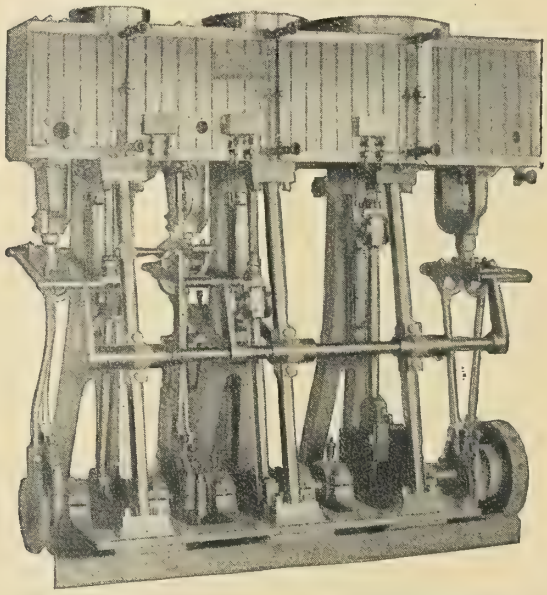
Repairs in all of the above branches upon reasonable terms.

Marine Engines

AND MACHINERY FOR YACHTS, PASSENGER BOATS AND TUGS.

Also makers of the well known

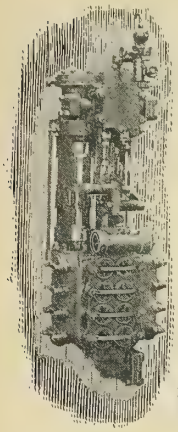
- - - PAINE PROPELLER WHEEL. - - -



Long Distance Telephone. Your Inquiries Solicited.

JAMES H. PAINE & SON,

Cor. Clayton and Park Sts., BOSTON, MASS.



The **SNOW**

Steam Pump Works,

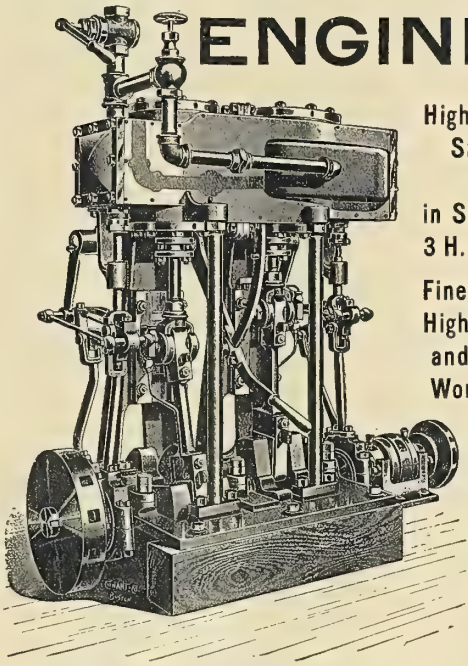
BUFFALO, N. Y.

Marine Pumps

FOR ALL SERVICES.

New York: 126 Liberty Street.
Philadelphia: 506 Drexel Building.
London: 98 Leadenhall Street.

MARINE ENGINES,



High Speed, Single and Compound, in Sizes from 3 H.P. upwards.

Fine Design, High Finish and First-class Workmanship.

Large Accessible Bearings with Automatic Lubrication, Light but Strong Construction.

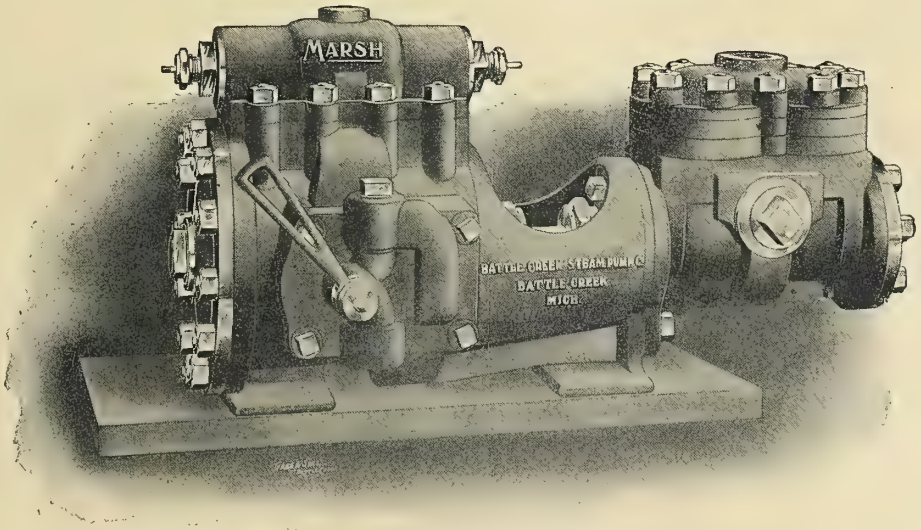
Moderate Prices.

Write for Circulars.

MORRIS MACHINE WORKS,
BALDWINSVILLE, NEW YORK.
New York Office, 39 & 41 Cortlandt Street.

BATTLE CREEK STEAM PUMP CO.,

Marsh Yacht Pump.

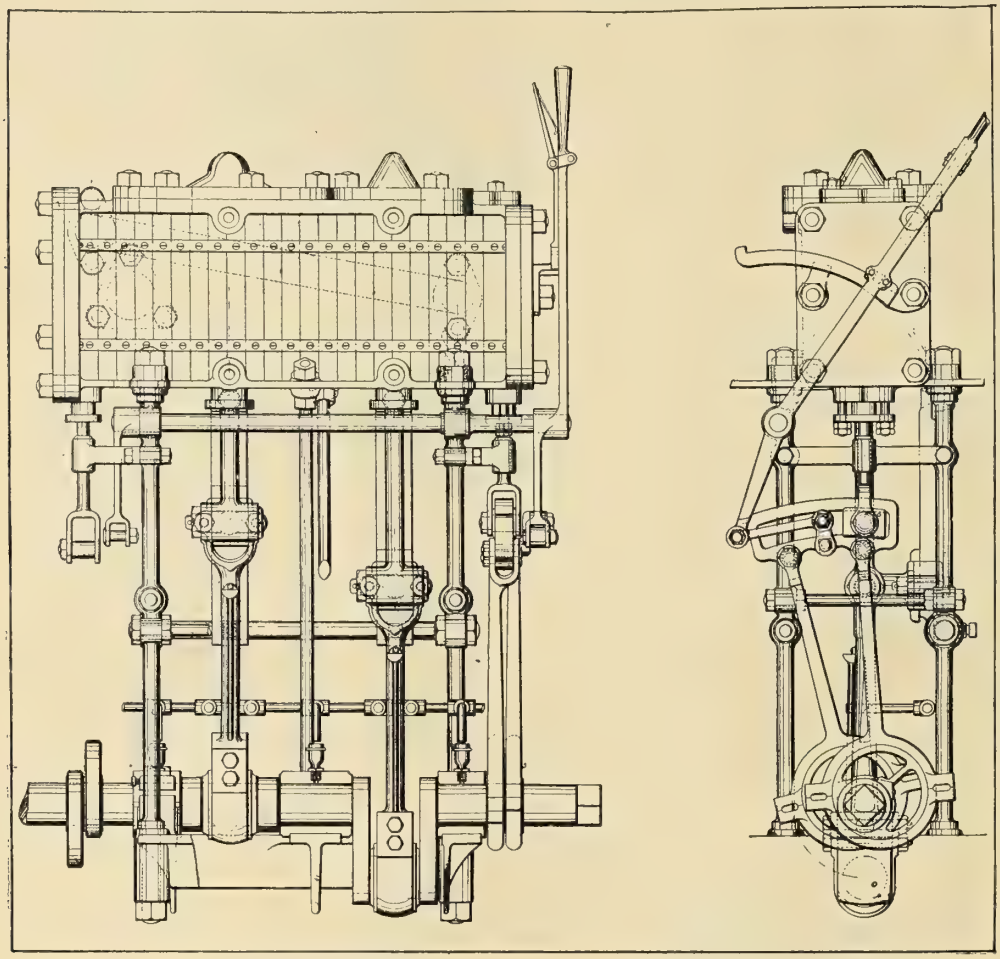


Catalogue or other information will be sent on application.

NOTE: Two Marsh Yacht Pumps on the "Ellide," the fastest yacht in the world.

CHARLES S. LINCH, MECHANICAL AND MARINE ENGINEER,

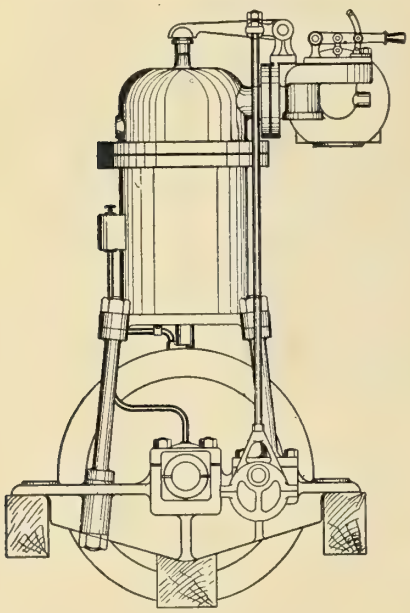
935 Drexel Building, 1501 South Front Street, Philadelphia, Pa.



Marine Engines,

High Speed Single, Compound, Triple and Quadruple Expansion.

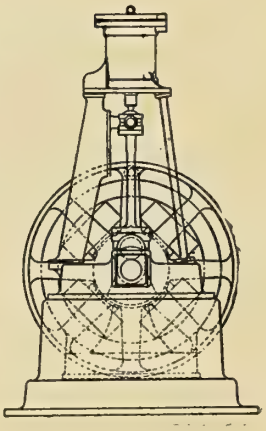
FOR STEAMSHIPS AND YACHTS.



Marine Oil Engines

Single and Double Acting. From 2 H.P. Up.

FOR LAUNCHES.



PROPELLER WHEELS.

COMPLETE MARINE OUTFITS

IN EITHER STEAM OR OIL.

SEAMLESS COLD DRAWN STEEL BOILER TUBES.

UNEXCELLED IN
STRENGTH, DURABILITY and EFFICIENCY.
MANUFACTURED FROM SOLID ROUND BAR.
Free from all Porousness and Physical Imperfections.

NO LAPS OR SEAMS OR WELDS.
Made from the Highest Grade of Material. Sulphur and Phosphorus Guaranteed not to exceed .025%.

CAN BE WELDED LIKE IRON.

DOES NOT PIT OR CORRODE like lap-welded tubing.
DOES NOT SPLIT OR CRACK when being expanded or re-rolled in tube sheet.
TUBES ARE VERY TOUGH and of increased density, owing to the cold drawing, and expanded tube ends hold tighter in tube-sheet than lap-weld tube.
TUBES ARE TRUE TO SIZE AND GAUGE and have very smooth inside and outside finish. This admits of much closer shop work than where lap welded tube is used.
TUBES ARE MUCH EASIER CLEANED than lap-welded, as the scale does not adhere so tightly to smooth surfaces as that of the lap-welded tube.
SEAMLESS TUBING CAN BE BENT into all kinds of shapes and with short radii without fear or failure, and has remarkable ductile and flanging properties.
The increased strength admits of higher steam pressure without decreasing of factor of safety.

CORRESPONDENCE SOLICITED.
Send us a sample order and verify the above statements.

Shelby Steel Tube Co., GENERAL SALES OFFICE, American Trust Bldg., CLEVELAND, O.

MILLS:
Ellwood City, Pa. Shelby, Ohio.
Greenville, Pa. Toledo, Ohio.

EUROPEAN OFFICE AND WAREROOMS:
29 Constitution Hill,
Birmingham, Eng.

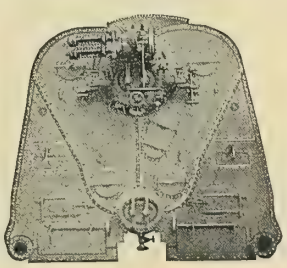
EASTERN OFFICE AND WAREROOMS:
No. 144 Chambers St.,
New York, N. Y.

WESTERN OFFICE AND WAREROOMS:
135 Lake St.,
Chicago, Ill.

Thornycroft Water-Tube Boiler.

450,000 Horse Power in Use.

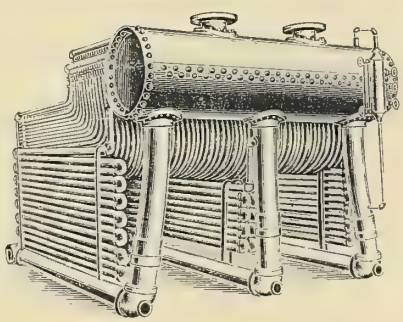
THREE OF THESE BOILERS WILL DEVELOP 6,300 I.H.P.



Nine United States Torpedo Boats fitted, also the Pennsylvania Railroad Ferry Boats "New Brunswick" and "Philadelphia." Highest Efficiency, Maximum Power, Minimum Weight and Space. From their light weight and great efficiency they are the best boilers to substitute for the old cylindrical boiler.

THORPE, PLATT & CO.,

9 CEDAR ST., NEW YORK.



Perspective view of the 250 H. P. boiler built for steamboat "Clara," having 6 feet face and 8 feet length; 37 7-12 square feet of grate area and 1900 square feet heating surface. Weight of boiler and water, 14,000 lbs.

We claim for the Boyer Sectional Water Tube Boilers, that they are of an entire new design, are simplest in construction, are accessible to all parts, are rapid steamers with short circulation, have low centre of gravity, have no joints in the fire, have no dead ends, occupy less space in width, length and height than any other, are easily fired, can be repaired or set up by any ordinary mechanic, do not require a brick casing and are shipped whole or knocked down into packages for transportation by man or beast.

BOYER PATENT SECTIONAL WATER TUBE BOILER CO.,

90 Wall Street, New York, N. Y.

LUNDELL DIRECT-CONNECTED GENERATING SETS.

These equipments are so designed that a minimum of weight and space occupied are obtained with no loss of power or efficiency as a consequence. They have no equal for steam yachts or steamships of any kind, and they are adapted for use in connection with any make of engine.

A FEW USERS:

J. Pierpont Morgan, ... Yacht "Corsair."
A. J. Drexel, ... Yacht "Marguerita."
Merchants' & Miners' Transportation Company.
M. C. D. Borden, ... Yacht "Vidette."
Tugboat "Daniel S. Lamont." Starin's Line.

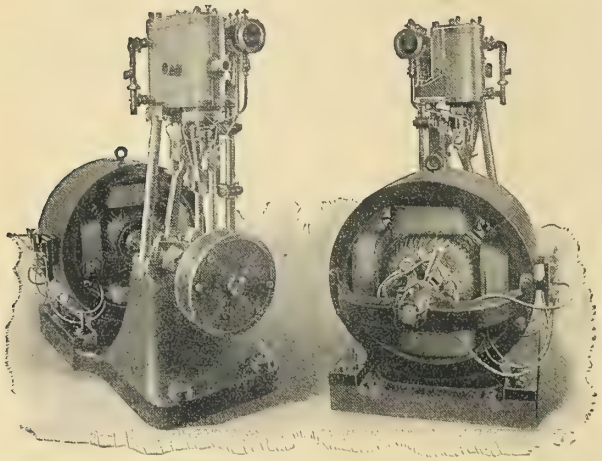
CORRESPONDENCE INVITED.

SPRAGUE ELECTRIC COMPANY,

Twenty Broad Street, New York City.

CHICAGO OFFICE: MARQUETTE BUILDING.

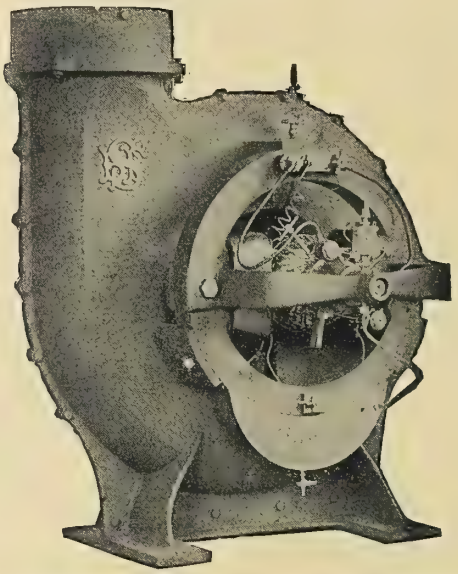
THE... BULLOCK Electric Mfg. Co.



Generator and Engine in W. R. Hearst's Yacht "Buccaneer."

CINCINNATI, O.

...STURTEVANT... ELECTRIC FANS.



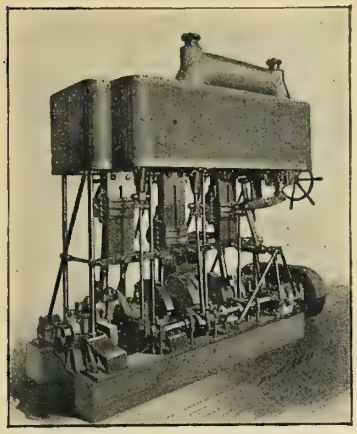
For VENTILATING and Similar Work.

Send for Catalogue.

B. F. STURTEVANT CO.

Works: Boston, Mass., U. S. A.

BOSTON. NEW YORK. CHICAGO. PHILADELPHIA. LONDON. GLASGOW. BERLIN. STOCKHOLM.



MARINE ENGINES

Quadruple and Triple Expansion, Compound and Simple. 15 to 3,000 Horse Power.

"Seabury's" Water Tube Boilers.
Steam and Sail Yachts.

The Only Naphtha Launch. *Send 10c. stamp for Catalogue.*

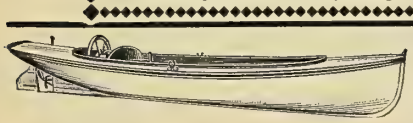
GAS ENGINE & POWER CO.,
AND
CHARLES L. SEABURY & CO.,
CONSOLIDATED,
Morris Heights, New York City.

BINDERS for MARINE ENGINEERING Handsomely Bound in Cloth, BY MAIL, 75c.

BEFORE BUYING a Boat, Canoe, Model Yacht Hull, Megaphone, Bicycle Touring Case, Sportsman's Carry-All, send for Catalogue of **Linenoid Seamless Outing Goods,** Manufact'd by **CRANE BROS., WESTFIELD, MASS.** Sold by Dealers in Sporting Goods.

STEAM YACHT FOR SALE.

A Steam Yacht, 81 ft. 6 in., with triple expansion engine, fully equipped, built in 1894.
Also a large stock of Marine Engines and Boilers.
FRANK TOOMEY,
129 & 131 N. THIRD ST., PHILADELPHIA, PA.



NOISELESS, FIRELESS, ODORLESS, ATTRACTIVE, INOFFENSIVE, INEXPENSIVE, NON-EXPLOSIVE, DURABLE, REVERSIBLE AND SAFE.
16-18-20 and 25-foot VAPOR LAUNCHES. Price, $150, $165, $225, $375 and $475.
Carvel Build, Copper Fastened, Speed 6 to 9 Miles. Capacity 8 to 20 People. Larger Size to Order. Also, all Sizes and Styles of Row and Sail Boats, Canoes, Dinghies, etc. Specialty of **Half** and **One Raters.** Send 8c. for Illustrated Catalogue to
Box D. RACINE YACHT & BOAT WORKS, Racine Junction, Wis.

"Shipped Set Up."

Size 4⅝ x 9 inches, Including Binding Post.

A PERFECT GAS ENGINE BATTERY.

Long Life. Cannot Slop.
Will Not Break.
No Acids Used.

Ready for immediate use on addition of water. Send for catalogue.

THE ELECTRIC GAS LIGHTING CO.,
195 Devonshire Street,
BOSTON, MASS.

JAMES C. WIGNALL, Boat Builder,

Beach and Vienna Sts., Kensington, Philadelphia, Pa.
Residence: 1025 PALMER STREET.

STEAM AND SAILING YACHTS, GUNNING, FISHING AND SPORTING BOATS
OF ALL DESCRIPTIONS BUILT TO ORDER.

Anything from a 16-Foot Tender to a 100-Foot Yacht.
Fitted with the Simplest, Safest, Speediest and Most Reliable of
MOTORS.

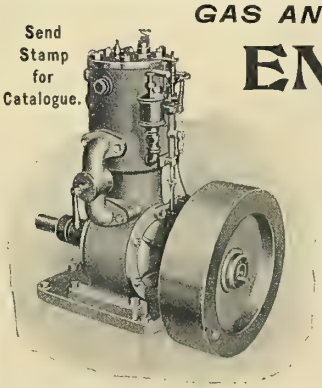
THE DAIMLER.

Made in Sizes from 1 to 25 Horse Power.
Everything in the Line of Boats. . . .
DAIMLER MOTOR WORKS,
937-945 Steinway Avenue, Steinway, Long Island City, N. Y.

GAS AND GASOLINE

ENGINES.

Send Stamp for Catalogue.



Both Stationary and Marine

ENGINE CASTINGS....

BOAT FRAMES.

A 16-foot Launch, Complete, $178.

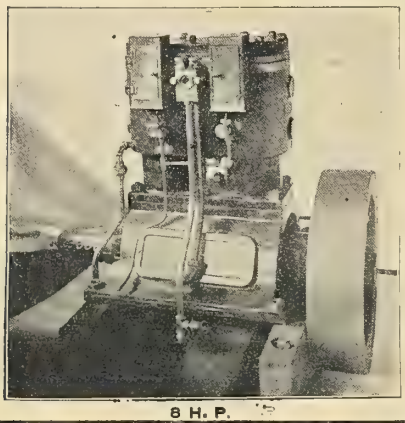
MIANUS ELECTRIC CO., Box M, Mianus, Conn.

ALCO VAPOR

Hunting Launch.

Sportsman's Floating Camp Motor controlled from bow. Valve movement, 12 to 1. 16 to 60 ft. Launches. Twin Screws a specialty. 1, 2, 3, 5, 7, and 12 h. p. No licensed engineer or pilot required. Speed and Safety guaranteed. **No dangerous Naphtha or Gasoline used.** No disagreeable vibration. SEND TEN CENTS IN STAMPS FOR 1897 CATALOGUE.

MARINE VAPOR ENGINE CO., Foot Jersey Ave., Jersey City, N. J.



8 H. P.

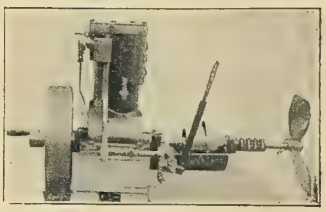
EMPIRE MARINE MOTOR

For Launches, Yachts and Working Boats.

Made by **C. C. RIOTTE CO.,** 1955 PARK AVE., NEW YORK CITY.

COMPACT,
SIMPLE,
LIGHT.

Sizes 1, 2 and 4 H. P. Single Cylinder; 2, 4, 6, 8, 12 and 20 H. P. Double Cylinder.



1 H. P.

IF YOU ARE GOING TO ALASKA FOR GOLD

Send Stamp for Circular. If you are not going you want to know all about our **Knock Down BOATS** just the same. We do the work, you nail together. Freight low.

AMERICAN KNOCK DOWN BOAT CO., ST. LOUIS, MO.

No Fire, Smoke or Heat. Absolutely Safe. Catalogue Free.
TRUSCOTT BOAT MFG. CO., ST. JOSEPH, MICH.

GAS ENGINES AND LAUNCHES.

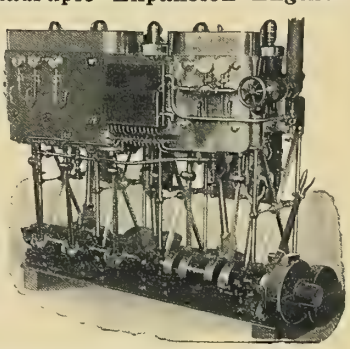
WOLVERINE MOTOR WORKS, GRAND RAPIDS, MICH.

THE FASTEST YACHT IN THE WORLD.

Triple and Quadruple Expansion Engines

GREATEST EFFICIENCY.
MAXIMUM POWER.
MINIMUM WEIGHT AND SPACE.

THE MOSHER PATENT WATER TUBE BOILER.
Over 11,000 horse power of these boilers in the torpedo boats of the U. S. N.



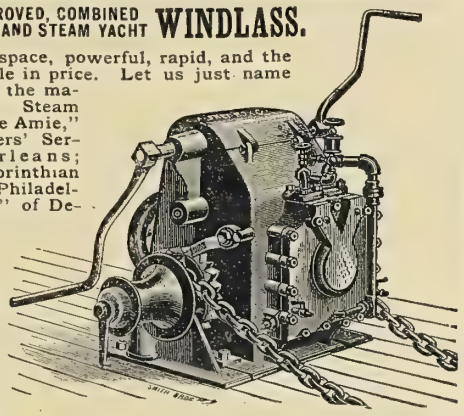
HIGH SPEED STEAM YACHTS A SPECIALTY.
Send for Illustrated Catalogue.
CHARLES D. MOSHER, 1 Broadway, New York.

Our New Catalogue of
YACHT, BOAT and CANOE HARDWARE and SUPPLIES
NOW READY.

Have You Sent For One?
They will be forwarded in the order in which the requests are received. Send 10 cents in stamps.
L. W. FERDINAND & CO.,
184 Federal St., Boston, Mass.

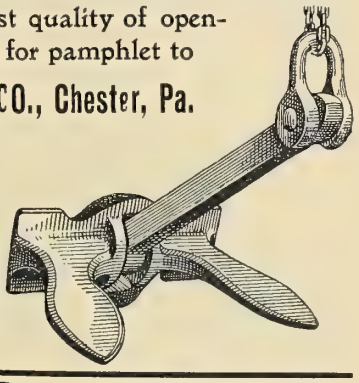
TREGURTHA WATER TUBE **BOILERS,** STEAM AND GASOLINE **LAUNCHES AND ENGINES.**
Send Five 2c. Stamps for Catalogue. MURRAY & TREGURTHA, Foot of F Street, South Boston, Mass.

BOX'S IMPROVED, COMBINED HAND AND STEAM YACHT **WINDLASS.**



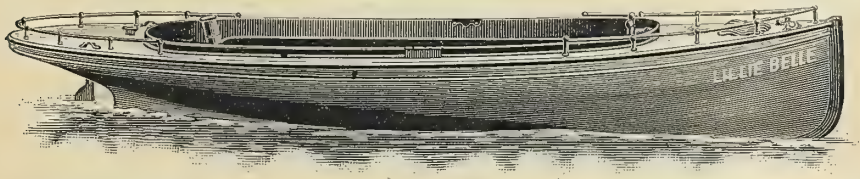
Minimum space, powerful, rapid, and the most reasonable in price. Let us just name one or two of the machines in use. Steam Yachts—"Chere Amie," U. S Engineers' Service, New Orleans; "Manatee," Corinthian Yacht Club, Philadelphia; "Truant," of Detroit, Mich.
Particulars Cheerfully Furnished.
ALFRED BOX & CO.,
Front, Poplar & Canal Sts.,
PHILADELPHIA, PA.

BALDT'S PATENT STOCKLESS ANCHOR.



Made of the finest quality of open-hearth steel. Send for pamphlet to
BALDT ANCHOR CO., Chester, Pa.
OR
THOS. PRICE,
136 Liberty St., N. Y.
WALTER MILLER,
Western Reserve Bldg.,
Cleveland, Ohio.

WYANDOTTE PLEASURE YACHT WORKS.

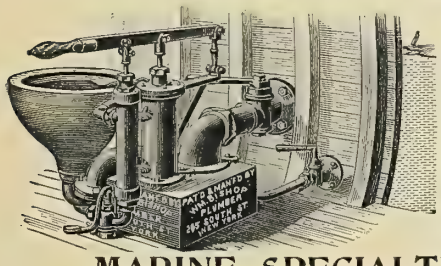


BUILDERS OF
HIGH GRADE BOATS,
STEAM and NAPHTHA
LAUNCHES, SAIL BOATS
ROW BOATS and CANOES.
Inclose 5 cents in stamps for 1898 catalogue.
Box 505, Wyandotte, Mich.

ALFRED B. SANDS & SON,

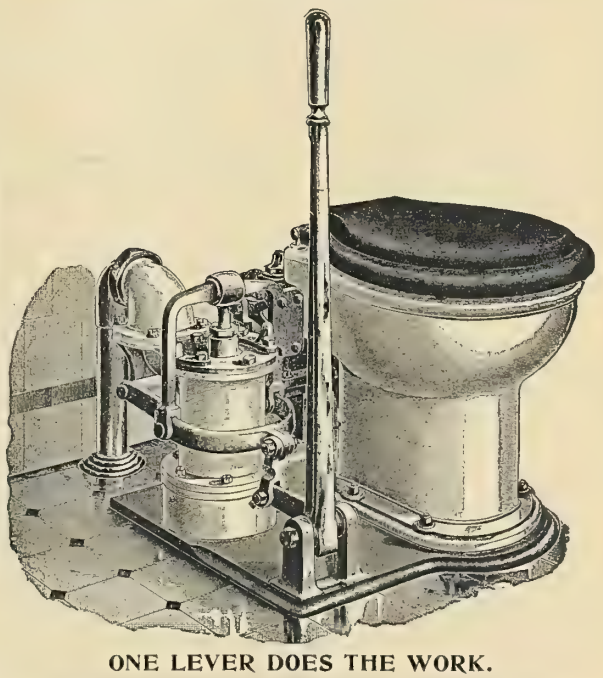
YACHT AND MARINE PLUMBERS,
And Manufacturers of
PUMP WATER CLOSETS
For above or below Water Line. Suitable for Naval Vessels, Yachts, Torpedo Boats and Launches,
PUMPS, TANKS, Etc., Etc.
134 BEEKMAN ST., - - NEW YORK.

PATENT PUMP WATER CLOSETS.



BRASS AND COPPER PUMPS, DECK PLATES, SEA COCKS, TANKS, VENTILATORS AND OTHER
MARINE SPECIALTIES.
Coppersmiths. Steam Fitters. Marine Plumbing.
WM. BISHOP'S SONS,
205 South St., NEW YORK. 724 Third Ave., BROOKLYN.
New York Telephone Call, 197 Franklin.

HOWELL'S PATENT
MARINE PUMP WATER CLOSET
THE "NEPTUNE"



ONE LEVER DOES THE WORK.
Circulars giving full information furnished upon application.
McCAMBRIDGE & CO., Ltd.,
523, 525 & 527 Cherry Street, PHILA., PA., U. S. A.

M. W. FOGG *Manufacturer of*

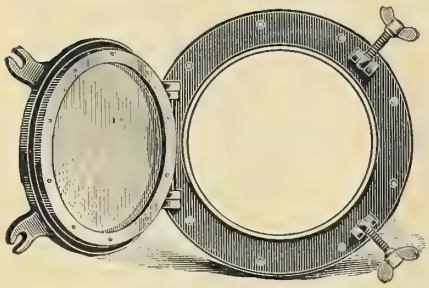
Cushions, Draperies and Bedding . . . .

FOR YACHTS, STEAMSHIPS, Etc.

195 Front St., Cor. Fulton St.

NEW YORK CITY

VESSEL MACHINERY AND SUPPLIES.



Windlasses, Captans, Pumps, Steering Apparatus.

Marine Monitor Side Lights.

Contractors' Supplies.

Shipbuilders' Supplies.

Oakum, Caulking Cotton, Deck Plugs, Pitch, Tar.

General Line of Ship Chandlery, Marine Hardware, Cordage, Wire Rope, Yacht Supplies, Flags, Signals, etc.

Marine Manufacturing & Supply Co., 158 South St., New York.

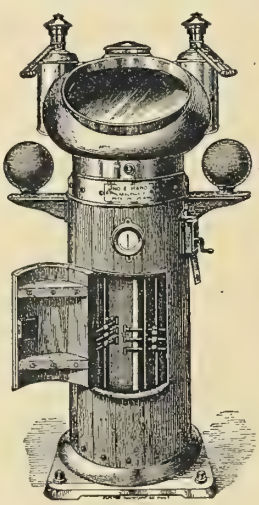
Established 1818.

RIGGS & BROTHER,

310 Market Street, Philadelphia, Pa.,

CHRONOMETER AND NAUTICAL INSTRUMENT MAKERS.

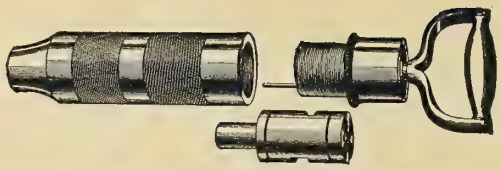
Agents for Ritchie's Spirit Compasses.



U. S. Government Charts and Nautical Books.

Estimates Given for Outfits for New Vessels. Special Attention to Outfits for Yachts.

Send for Catalogue and Almanac.



It has only three parts. Cannot get out of order. We Guarantee it for two years.

THE CLEMENT PNEUMATIC TOOL COMPANY,

123-125 South Eleventh St., PHILADELPHIA, PA.

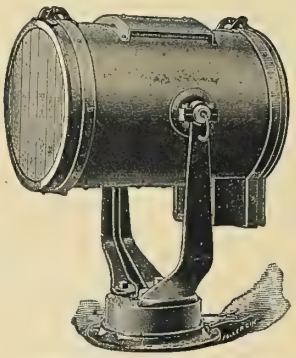
PNEUMATIC TOOLS

and Appliances for Chipping and Caulking Boilers and Ships.

REFERENCE:—Wm. Cramp & Sons, Ship and Engine Building Co., Philadelphia, Pa.

Catalogue on Application.

Electric Search Lights



FROM 1,000 to 10,000 Candle Power

ADAPTED TO

Lake & Ocean Vessels,

ALSO TO

Launches and Yachts.

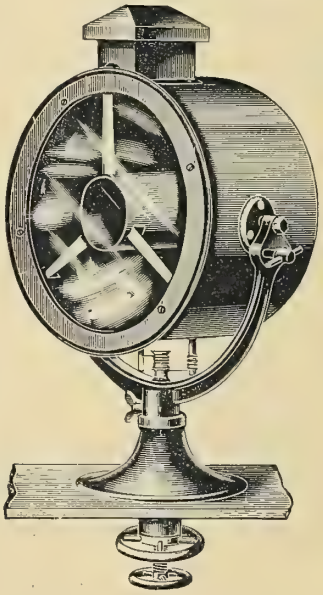
SEND FOR CATALOGUE "A."

The Carlisle & Finch Co.,
834 W. 6th STREET,
CINCINNATI, OHIO.

EVERY YACHTSMAN MAY HAVE A

SEARCH LIGHT

WITHOUT ELECTRICITY.



Adding to the Pleasure of an Evening Sail.

Helpful in Making Landings and Picking Up Moorings.

MECHANICALLY PERFECT, POWERFUL, CONVENIENT, ECONOMICAL.

Send for Information and mention "Marine Engineering."

J. B. COLT CO., DEPT. B 1, 3 to 7 W. 29th St., New York.

Our Drills are Hot Forged

Consequently Tough and Strong.

ESPECIALLY ADAPTED FOR DRILLING

ARMOR AND BOILER PLATE.

NEW PROCESS TWIST DRILL COMPANY. TAUNTON MASS.

PLEASE WRITE US FOR CATALOGUE AND DISCOUNT SHEET.

KILBOURN CONSTRUCTION CO.,

935 Drexel Building, Philadelphia, Pa.

36 Machines

on Steamers of

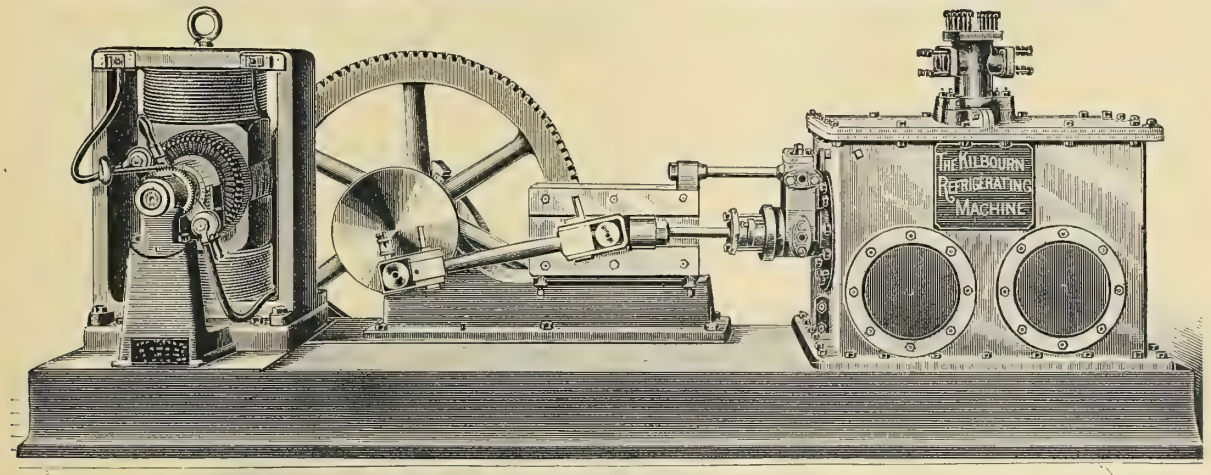
The International Navigation Company.

Following Steamship Lines Equipped:

Cunard, Leyland, Houston, Guion, Warren.

Small Machines Specially Designed for Yachts.

Pioneers in Steamship Refrigeration.



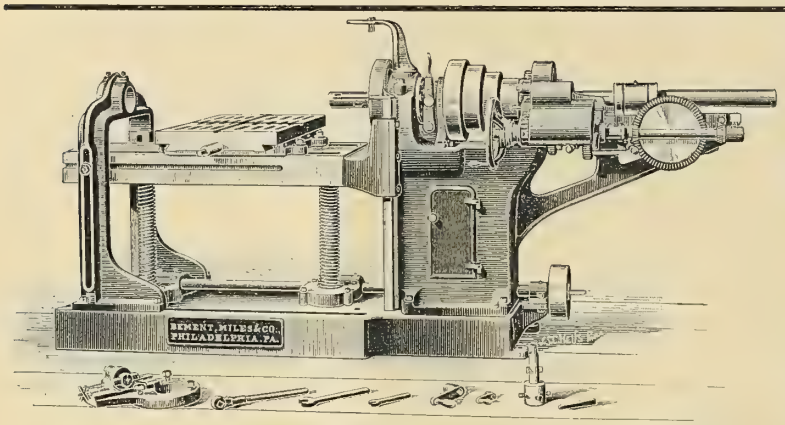
KILBOURN MACHINE ON CRUISERS "ST. PAUL" AND "ST. LOUIS."

THREE-GROOVE CHUCKING REAMER.

See p. 16 of our 1898 catalogue. Send for a copy.

MORSE
TWIST DRILL
AND MACHINE CO.,
NEW BEDFORD, MASS., U. S. A.

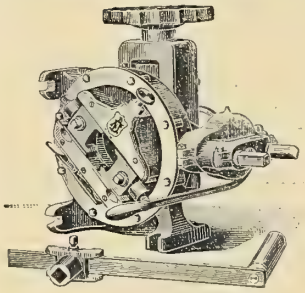
BURDEN IRON CHAIN, AMERICAN CHAIN CABLE WORKS.
The J. B. Carr Company, Troy, N. Y.,
Manufacturers of
CABLE, SHIPPING, CRANE, DREDGE, STEERING, QUARRY, and RAFTING CHAINS.
All Chains and Cables made of Especially Rolled Iron and Warranted to Stand Government Test.



No. 1 HORIZONTAL BORING AND DRILLING MACHINE.

BEMENT, MILES & CO.,
PHILADELPHIA, PA.,
Manufacturers of
METAL WORKING MACHINE TOOLS
For Shipyards, Boiler Shops, and all kinds of
METAL WORKING ESTABLISHMENTS.
NEW YORK OFFICE: Taylor Bldg., 39 Cortlandt Street
Chicago Office, 1534 Marquette Bldg.

ARMSTRONG'S TOOLS FOR MARINE WORK ARE BEST.



No. O Threading Machine.

Improved Pipe Threading and Cutting Off Machines.
Sizes, ⅛ to 6 inches. Hand or Power.

ARMSTRONG'S Celebrated Adjustable STOCKS and DIES. Universally acknowledged to be the best on the market.

Pipe Wrenches, Pipe Cutters, Clamp Dogs, and other Tools for Water, Gas and Steam Fitters' Use.

New No. 3 Pipe Cutter.

GOT A CATALOGUE?

THE ARMSTRONG MFG. CO.,
N. Y. Office: 139 Centre Street.
BRIDGEPORT, CONN.

CABLES: Niles, Hamilton, Ohio.

No. 5 BENDING-ROLLS
For Plates 3/4 in. x 12 ft., Cold.

ROLLS For All Sizes Ship and Boiler Plate.

THE NILES TOOL WORKS COMPANY,
HAMILTON, OHIO.

Complete Equipments For
SHIP YARDS,
BOILER YARDS,
AND
MACHINE SHOPS.

MACHINE-TOOLS.

Branches:
NEW YORK, CHICAGO,
BOSTON, PITTSBURGH,
PHILADELPHIA, ST. LOUIS.
LONDON, S. W., 39 Victoria Street.
(*Telegrams*, "*Niliacus, London.*")

Want Your Papers Raised? WE CAN HELP YOU.

Thorough Instruction by Mail in . . . . Marine, Stationary and Electrical Engineering.

Write for Free Circular W.
The United Correspondence Schools,
F. W. EWALD, Gen. Mngr. 154-158 Fifth Avenue, New York.

FORGINGS.

Heavy or Light, Steel or Iron,
Marine, Stationary, or Special,
Rough or Finished Complete.
The Whitestone Forge & Construction Co.,
Offices, 11 Broadway, New York

BOOKS.

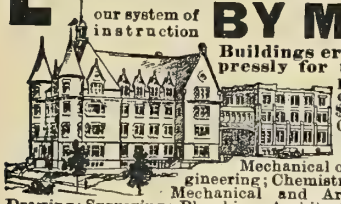
Every man interested in marine work should have at hand the best books devoted to the latest developments in engineering as applied to marine work.
Marine Engineering can supply them at market rates.

HOLMES, BOOTH & HAYDENS,
WATERBURY, CONN.
NEW YORK OFFICE: 37 PARK PLACE.

Seamless Brass and Copper Tubing
for condensers, heaters, steam pipes and other coppersmith work.
Also **Sheet Brass and Copper.**

EDUCATION BY MAIL

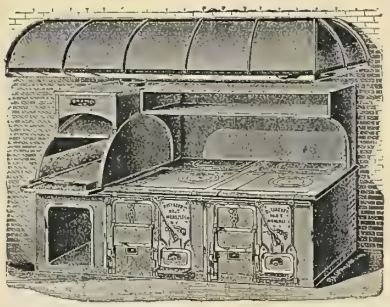
Thousands have been helped to better pay & positions through our system of instruction



Buildings erected expressly for this purpose at a cost of $225,000
Courses of Steam, Electrical, Mechanical or Civil Engineering; Chemistry; Mining; Mechanical and Architectural Drawing; Surveying; Plumbing; Architecture; Metal Pattern Drafting; Prospecting; Bookkeeping; Shorthand; English Branches.

$2 A MONTH pays for a College Education at Home.
45,000 Students and Graduates.
Circular FREE. State subject you wish to study.
THE INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 1111, Scranton, Pa.

FRENCH COOKING RANGES,



and Cooking Apparatus of every description for Steamships, Yachts etc

Established 1852.

Branch Salesrooms,
79, 81, 83
Market Street,
Chicago, Ill.;
6 Union Street,
Boston, Mass.

DUPARQUET, HUOT & MONEUSE CO.
Office and Warerooms: 43 & 45 Wooster St., New York City.

12,000 in Use.

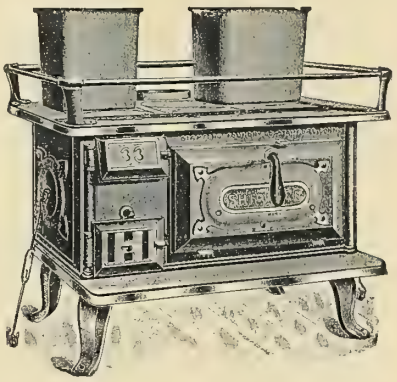
Unaffected by Weather. Portable, Self Contained

800 to 4000
CANDLE POWER FROM
KEROSENE OIL.

Especially adapted for Repair Jobs, Work in Docks, Foundries, Boiler Shops, and elsewhere where a portable and powerful light is needed.

400 RAILROADS and over **500** CONTRACTORS NOW USE THE WELLS LIGHT.

THE WELLS LIGHT MFG. CO.,
EDWARD ROBINSON, Sole Proprietor.
46 Washington St., New York.



Although we have mentioned the fact before, it may be well to repeat that we make several sizes of Shipmates, besides several sizes of Yacht Ranges.

The Yachts are for small vessels.

Our special vessel range catalogue, which we send free, describes them all.

THE STAMFORD FOUNDRY COMPANY,
STAMFORD, CONN.
Established 1830.

U. T. HUNGERFORD.

GEORGE DAVIDSON.
BERNARD RIS.
J. R. VAN BRUNT.

TELEPHONE,
259 FRANKLIN.

U. T. HUNGERFORD,

Brass and Copper,

121 Worth St., between Centre and Elm Sts., New York.

SEAMLESS BRASS AND COPPER TUBING

For Condensers, Heaters, Steam Pipes and Coppersmiths' Work generally.

SHEET AND BOLT COPPER.

YELLOW METAL SHEATHING, BOLT AND NAILS.

BRASS AND COPPER

In every Variety of Shape and Form.

We carry a large stock of all above goods on hand for prompt shipment.

Catalogues and Prices Submitted on Application.

SEAMLESS DRAWN

Brass and Copper Tubing

GUARANTEED QUALITY,

FOR

Coppersmiths' Work, Steam Pipes, Condensers, Heaters, &c., &c.

SHEETS, RODS, WIRE, IN COPPER, BRASS, BRONZE.

Yellow Metal Sheathing Bolts and Nails.

MATERIAL FOR SHIP WORK A SPECIALTY.

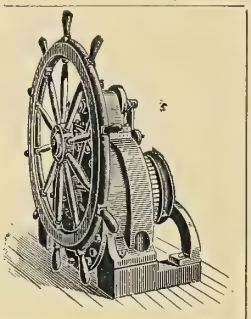
Manufacturers of

BABBITT AND ANTI-FRICTION METALS.

MERCHANT & CO., Incorporated.

PHILADELPHIA, 517 Arch St.
CHICAGO, 36 La Salle St.
NEW YORK, 245-7 Water St.
BROOKLYN, 584 Flushing Ave.

Queen City Patent Hydraulic Steerer.



THE BEST AND MOST RELIABLE.
GENERATES NO HEAT IN PILOT HOUSE.

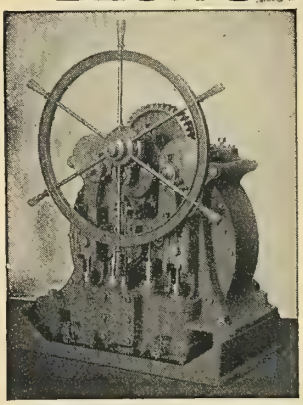
Has Large Hand Wheel.
Can be Changed from Power to Hand Steering Instantly.
A Favorite with Pilots.

SEND FOR REFERENCES.

QUEEN CITY ENGINEERING CO.,

BUFFALO, N. Y.

BECK'S PATENT STEERING GEAR.



Steam and Hand.
Built in all Sizes.
Simplest, Strongest,
Most Reliable.
Changed from Steam to Hand or back by One Lever in less than One Second.

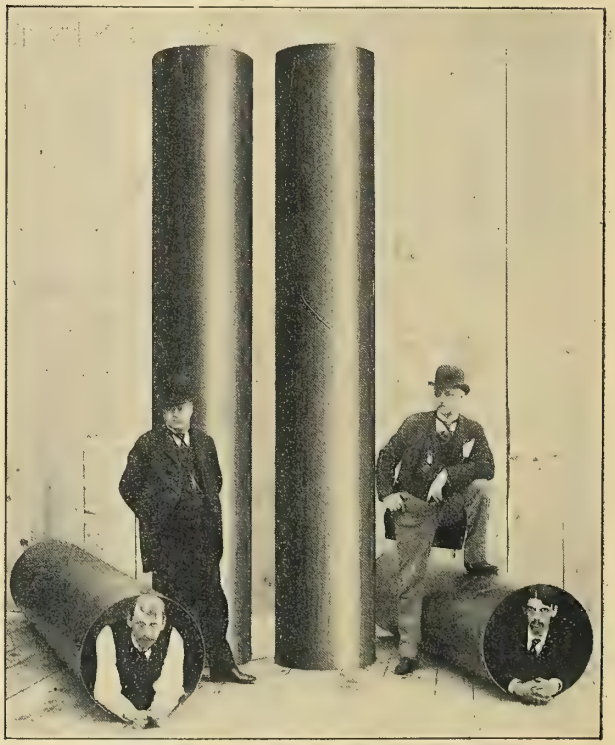
BUILT BY

PAWLING & HARNISCHFEGER,

MILWAUKEE, WIS.

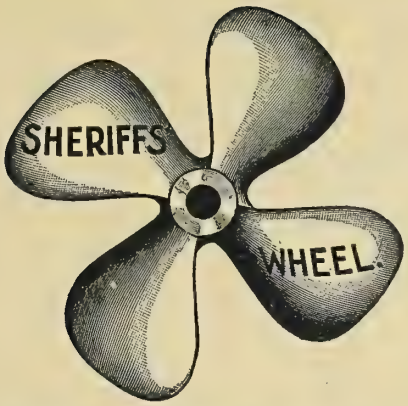
COLD DRAWN SEAMLESS COPPER AND BRASS TUBES

from 1-16 up to 38 inches in diameter.

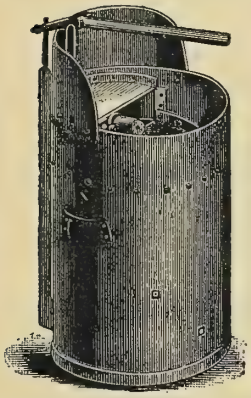


RANDOLPH & CLOWES, Waterbury, Conn.

BRANCH OFFICES: NEW YORK, Room 202 Postal Telegraph Building. PHILADELPHIA, Room 320 Philadelphia Bank Building. CINCINNATI, Room 308 Neave Building. CHICAGO, 226 Lake Street. BOSTON, Oliver Street Corner of Purchase Street.



Sheriffs Manufacturing Co.,
MILWAUKEE, WIS.



THE CRUMLISH
PORTABLE FORGE
FOR RIVET HEATING.

The strongest, lightest and handiest forge on the market. Constructed of steel, circular in form; weighs only 90 pounds; 19 inches in diameter. Used by the leading steamship companies and shipyards of the United States.

SEND FOR CIRCULAR.

The Crumlish Forge Co.,
BUFFALO, N. Y., U. S. A.

GEORGE W. PIPER,

IMPORTER AND MANUFACTURER OF

ENAMELS AND PAINTS FOR YACHTS AND STEAMSHIPS.

SOLE SELLING AGENT FOR THE U. S. FOR **McINNES'S**

(ENGLISH) COMPOSITIONS

FOR THE BOTTOMS OF IRON AND STEEL SHIPS.

MANUFACTURED BY

JOHN McINNES & SON, Liverpool, England.

Office, 55 South St., New York.

Telephone Call, 1326 Broad.

Beware of imitations that are being sold on the market as the McInnes.

Paul S. Reeves & Son,

PHILADELPHIA, PA.,

Manufacturers of

Propeller Wheels

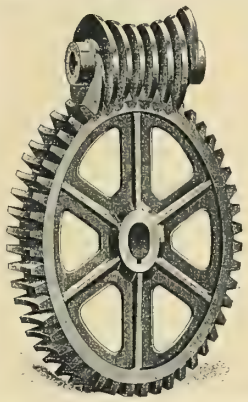
in all the BRONZES.

Marine Castings a Specialty.

Phosphor-Bronze, Brass, Babbitt Metals.

Castings from ¼ to 10,000 lbs. Weight.

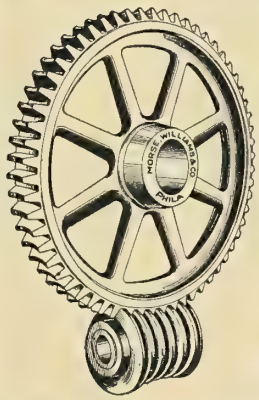
HINDLEY AND ALBRO



Worm Gearing.

Order promptly—as our naval orders keep us busy.

Albro-Clem Elevator Co.,
Philadelphia, Pa.,
U. S. A.



HINDLEY WORM GEARING

Is in general use in the machinery of modern vessels. Write for our descriptive circular, showing how this style gearing gives THE BEST RESULTS.

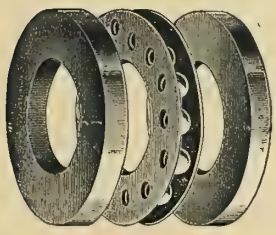
MANUFACTURED BY

MORSE, WILLIAMS & CO.,
PHILADELPHIA, PA.

BALL THRUST COLLARS

...FOR...

PROPELLER SHAFTS.



THEY CANNOT HEAT. *HUNDREDS HAVE*
THEY SAVE POWER. *BEEN APPLIED BY*
THEY ARE DURABLE. *LEADING BOAT BUILDERS.*

THE BALL BEARING CO.,
7 WATSON STREET, BOSTON, MASS.
New York Office: 121 Liberty Street.

WRITE FOR CATALOGUE.

The Charles Hillman Ship and Engine Building Co.

Beach above Palmer St., Philadelphia, Pa.

THE CHICAGO SHIP BUILDING COMPANY,

SHIP BUILDERS and ENGINEERS,

CHICAGO.

THE CLEVELAND SHIP BUILDING CO.

Steel Ships.

Marine Engines and Boilers.

T. S. MARVEL & CO., NEWBURG, N. Y.

SHIP AND ENGINE BUILDERS.

The Atlantic Works,

BORDER, MAVERICK and NEW STS., EAST BOSTON, MASS.

(Docks opposite Navy Yard.)

Builders of

STEAMSHIPS, TOW BOATS AND STEAM YACHTS,

IN STEEL AND WOOD.

Marine Engines, Boilers, etc. Hull, Boiler and Engine Repairs.

Cramp's Ship Yard,

PHILADELPHIA, PA.

Battle Ships, Cruisers, Passenger and Freight Steamships, etc.

STEAM MACHINERY of every description, including boilers and all equipment; Marine Engines of any desired power Gun Carriages, Basin Dry Dock and Marine Railway, Parsons' Manganese Bronze and White Brass, Water Tube Boilers (Niclausse, Mosher, Yarrow).

AREA OF PLANT, thirty-two acres. Area covered by buildings, fifteen acres. Delaware river front, 1,543 feet.

FLOATING DERRICK "ATLAS": capacity 130 tons, with 60 feet hoist and 36 feet out-hang of boom.

NUMBER OF MEN EMPLOYED, about 6,000 in all departments.

Roach's Shipyard.

The Delaware River . Iron Shipbuilding and Engine Works, . . .

Chester, Pa.

Builders of Steamships and Marine Machinery. Facilities for Work of Every Description.

General Office and Works, - - CHESTER, PA.

New York Office:
MORGAN IRON WORKS, Foot East Ninth Street.

Established 1863. Incorporated 1867.

The Harlan & Hollingsworth Co.,

Wilmington, Delaware, U. S. A.,

SHIP BUILDERS.

Iron and Steel Vessels of all Kinds.

Engines, Boilers and Machinery Generally.

Torpedo Boat Destroyers.

STEAM AND SAILING

YACHTS

OF THE HIGHEST CLASS

A SIMPSON PATENT BASIN

DRY DOCK

OF 340 FEET LENGTH AND 14 FEET OF WATER

Special Designs and Specifications.

MARINE RAILWAYS.

TEBO'S
YACHT BASIN, COALING STATION
AND FLOATING DRY DOCKS,
Foot 23d Street, BROOKLYN, N. Y.

BROOKLYN
FLOATING DOCK AND SHIPYARD.
THEO. A. CRANE'S SONS, PROPRIETORS,
Erie Basin, South Brooklyn.
CAPACITY OF DOCK, 1200 TONS. LENGTH OF KEEL BLOCKS, 200 FEET.
Telephone, 236 Hamilton.

LEWIS NIXON,
Shipbuilder.
Office and Works:
Elizabethport, N. J.

BUILDER OF STERN WHEEL, PADDLE AND SCREW

Steamers, also
Torpedo Boats
and **Barges**
OF ALL KINDS IN STEEL.

A SPECIALTY MADE OF
South American and Alaskan River Boats.

Marine Engineering can supply any book devoted to Marine Matters.

NEWPORT NEWS SHIPBUILDING & DRY DOCK CO.
WORKS AT NEWPORT NEWS, VA.
(ON HAMPTON ROADS.)
Equipped with a Simpson's Basin Dry Dock capable of docking a vessel 600 feet long, drawing 25 feet of water, at any stage of the tide. Repairs made promptly and at reasonable rates.
SHIP AND ENGINE BUILDERS. : :
For estimates and further particulars, address
C. B. ORCUTT, Pres't, No. 1 Broadway, New York.

FRANKFORD STEEL COMPANY, ELLWOOD CITY, LAWRENCE CO., PA.
STEEL FORGINGS, HEAVY SHAFTINGS.
In the Rough, Rough Turned or Finished. Office, Fidelity Mutual Building, PHILADELPHIA.

FORGINGS

of Acid Open Hearth Steel, Nickel Steel, etc., from ingots cast at our own works, under hydraulic pressure, subsequently forged under hydraulic presses, and carefully annealed.

THE BETHLEHEM IRON COMPANY,

South Bethlehem, Penna.

No. 100 Broadway, New York City, N. Y.
No. 421 Chestnut Street, Philadelphia, Pa.
No. 1433 Marquette Building, Chicago, Ill.

Established 1838. *Incorporated 1891.*

THE NEAFIE & LEVY
Ship and Engine Building Co.,

Penn Works, Philadelphia, Pa., U. S. A.

BUILDERS OF

Iron and Steel Ships and Engines

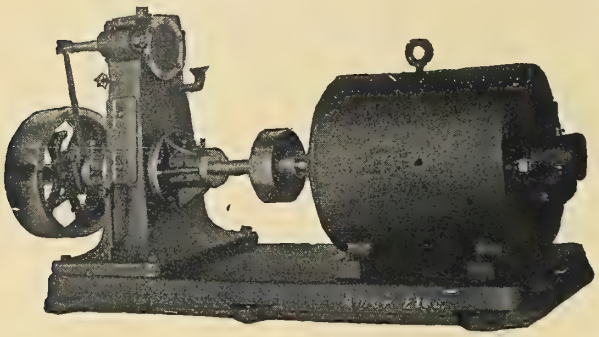
OF EVERY DESCRIPTION.

Steamship Repairs A Specialty.

Office:
1336 Beach St., Philadelphia, Pa.

Marine Generating Sets.

In sizes from 2 1-2 k.w. to 15 k.w.



In these sets our well known Closed Type Ironclad Dynamo is used, making the outfit practically waterproof.

Electric Power Tra smission Systems for Shipyards.

Generators and Motors of all Standard Types and for all purposes.

THE C & C ELECTRIC COMPANY,

Main Offices, New Jersey Central Bldg., NEW YORK.

Sales Offices or Agencies in all leading cities.

Write for Bulletins and Prices.

..BETTER THAN DRY DOCKS..

CRANDALL'S MARINE RAILWAYS.

Constructed of either timber or steel for ships of any size.

Plans and estimates, machinery and materials.

H. I. CRANDALL & SON, ENGINEERS,

100 Border Street, East Boston, Mass., U S. A.

INDEX TO ADVERTISERS.

ANCHORS.

Baldt Anchor Co. 53

ANCHOR CABLES.

Carr, J. B. Co., The 56

AUXILIARY STEAM APPLIANCES AND FITTINGS.

American Steam Gauge Co. 39
Ashton Valve Co. ..... inside front cover
Battle Creek Steam Pump Co. 47
Bloomsburg, H. & Co. 44
Craig, Wm. 42
Deane Steam Pump Co. ..... inside front cover
Eynon-Evans Mfg. Co. 42
Learmouth, Robert 44
Mason Regulator Co. 36
Penberthy Injector Co. 41
Robertson, Jas. L. & Son 36
Ross Valve Co. 44
Snider-Hughes Co., The 43
Snow Steam Pump Works 47
Taunton Locomotive Mfg. Co. 42

BEARINGS.

Ball Bearing Co., The 59
Graphite Lubricating Co. 40

BOILERS.

Almy Water Tube Boiler Co. 45
Boyer Patent Sectional Water Tube Boiler Co. 49
Clark, Edw. S. 46
De Puy, Captain M. 45
Kingsford Foundry & Machine Works 45
Rochester Machine Tool Works 45
Thorpe, Platt & Co. 49
Tonkin, J J 46
Watson, E. P 45

BOILER COMPOUND.

Warley, Thomas C. & Co. 42

BOILER TUBES.

Shelby Steel Tube Co. 49

BRASS AND COPPER.

Holmes, Booth & Haydens 57
Hungerford, U. T. 58
Merchant & Co. 58
Randolph & Clowes 58

CAPSTANS AND WINDLASSES.

Box, Alfred & Co. 53
Hyde Windlass Co. ..... outside back cover

COALING AND FUELING DOCKS.

Toms Creek Coal & Coke Co. ..... outside back cover

DRAUGHTSMEN'S SUPPLIES.

Alteneder, Theo. & Sons 46
Keuffel & Esser Co. ..... outside back cover

DREDGING.

New York Dredging Co. ..... outside back cover

EDUCATIONAL.

International Correspondence Schools. 57
United Correspondence Schools 57

ELECTRICAL APPARATUS AND SUPPLIES.

Bullock Electric Mfg. Co. 50
C & C Electric Co. 62
Electric Gas Lighting Co. 51
Sprague Electric Co. 50
Sturtevant Co., B. F. 50

ENGINES—GASOLINE.

Mianus Electric Co. 51
Riotte, C. C. Co 52

ENGINES—STEAM.

Forbes, W. D. & Co. 43
King, Charles L. 46
Linch, Chas. L. 48
Morris Machine Works 47
Paine, James H. & Son 46
Riley & Cowley 46
Toomey, Frank 51

FORGES.

Crumlish Forge Co. 59

FORGINGS AND CASTINGS.

Bethlehem Iron Co. 61
Frankford Steel Co 61
Whitestone Forge & Construction Co 57

LAMPS, SIGNALS AND FIXTURES.

Lovell, F. H. & Co 63
Porter's Sons, Wm. 63
Russell & Watson 63

LUBRICATION.

Burt Manufacturing Co.....inside front cover
Dixon, Joseph, Crucible Co.....35
National Lubricator Co.....44
Phillips, W. P. & Co.....37

MARINE RAILWAYS.

Crane's Sons, Theodore A.....61
Tebo's Dry Dock Co.....61

MARINE RAILWAY BUILDERS.

Crandall, H. I. & Son.....62

MARINE STORES AND SUPPLIES.

American Mfg. Co.....inside front cover
Edson Mfg. Co.....35
Ferdinand, L. W. & Co.....53
Fogg, M. W.....54
Marine Manufacturing & Supply Co.....54
Riggs & Bro.....54

METAL POLISH.

Bertram's Oil Polish Co.....outside back cover
Cole, J P.....37
Rath Mfg. Co.....37

MISCELLANEOUS.

Goerz, C. P.....36
Great Lakes Register.....39
Rochester Optical Co.....39
Wells Light Mfg. Co.....57

NON-CONDUCTING COVERINGS.

Keasbey, Robert A.....45

PACKING.

Boston Belting Co.....40
Brandt, Randoph.....40
Chesterton, A. W. & Co.....inside back cover
Daniel, C. A.....35
Garlock Packing Co.....40
Katzenstein, L. & Co.....42
Knowlton Packing Co.....42
Mabbs Hydraulic Packing Co.....37
Peerless Rubber Mfg. Co.....38
St. John Cylinder Packing Co.....40

PAINTS AND PRESERVATIVES.

Piper, George W.....59

PROFESSIONAL CARDS.

H. B. Roelker.....37

PROPELLER WHEELS.

Reeves, Paul S. & Son.....59
Sheriffs Mfg. Co.....59

RANGES—SHIP AND GALLEY.

Duparquet, Huot & Moneuse Co.....57
Stamford Foundry Co.....57

REFRIGERATING MACHINES.

Kilbourn Construction Co.....55

SEARCH LIGHTS.

Carlisle & Finch Co.....54
Colt, J. B. & Co.....54

SHIP BUILDERS.

Atlantic Works.....60
Chicago Ship Building Co.....60
Cleveland Ship Building Co.....60
Cramp, Wm. and Sons. Ship and Engine Building Co.....60
Delaware River Iron Ship Building & Engine Co.....60
Detroit Dry Dock Co.....62
Harlan & Hollingsworth Co.....60
Hillman, Chas., Ship and Engine Building Co.....60
Marvel, T. S. & Co.....60
Neafie & Levy Ship & Engine Building Co.....61
Newport News Ship Building and Dry Dock Co.....61
Nixon, Lewis.....61

SPEED-CONTROLLING APPARATUS.

Monarch Mfg. Co.....43

STEERING APPARATUS.

Pawling & Harnischfeger.....58
Queen City Engineering Co.....58

TOOLS—BENCH.

Clement Pneumatic Tool Co.....54
Morse Twist Drill & Machine Co.....56
New Process Twist Drill Co.....55
Williams, J. H. & Co.....outside back cover

TOOLS—MACHINE.

Armstrong Mfg. Co.....56
Eames Co, The G. T.....36
Bement, Miles & Co.....56
Niles Tool Works Co.....56
U. S. Metallic Packing Co.....39

WATER CLOSETS.

Bishop's, Wm. Sons.....53
McCambridge & Co., L't'd.....53
Sands, Alfred B. & Son.....53

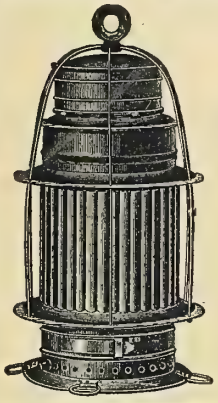
WORM GEARING.

Albro-Clem Elevator Co.....59
Morse, Williams & Co.....59

YACHT AND BOAT BUILDERS.

American Knockdown Boat Co.....52
Crane Brothers.....51
Daimler Motor Works.....51
Gas Engine & Power Co. and C. L. Seabury & Co., Consd...51
Marine Vapor Engine Co.....52
Mosher, Chas. D.....52
Murray & Tregurtha.....53
Racine Yacht & Boat Works.....51
Truscott Boat Mfg. Co.....52
Wignall, Jas. C.....51
Wolverine Motor Works.....52
Wyandotte Pleasure Yacht Works.....53

ADMIRAL DEWEY'S DESPATCH BOAT,



the Revenue Cutter McCulloch,

is fitted with our

10 inch Head and Side Lights and 8 inch Anchor Lights.

RUSSELL & WATSON,

145 Main St., Buffalo, N. Y.

MARINE LAMPS

Oil and Electric.

Signals, Fixtures, Etc.

WM. PORTER'S SONS,

271 PEARL STREET, NEW YORK.

MARINE LAMPS OIL, ELECTRIC AND COMBINATION

For Government or Private Use

Box Lamps, Ceiling Fixtures, Bunker Lamps, Diving Lamps, Signal Lamps and Side Lights

Steam Tight Globes, Chimneys, Lantern Globes and All Kinds of Glassware

Marine Electrical Material

F. H. LOVELL & CO. 118 John & 231-233 Pearl Sts. New York

HOWDEN HOT DRAFT.

TOTAL INSTALLATIONS THROUGHOUT THE WORLD

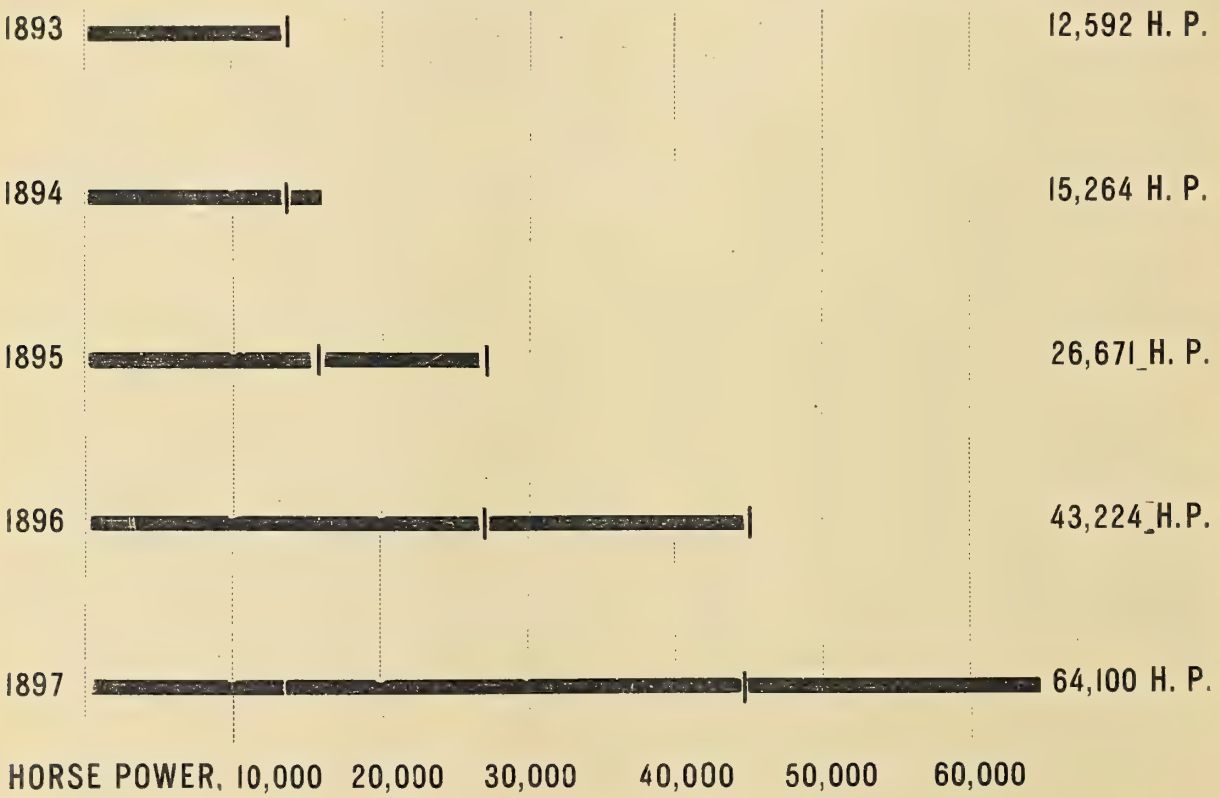
724 STEAMERS---1,830,100 HORSE POWER.

TOTAL INSTALLATIONS BY THE

DRY DOCK ENGINE WORKS, DETROIT,

55 STEAMERS--64,100 HORSE POWER.

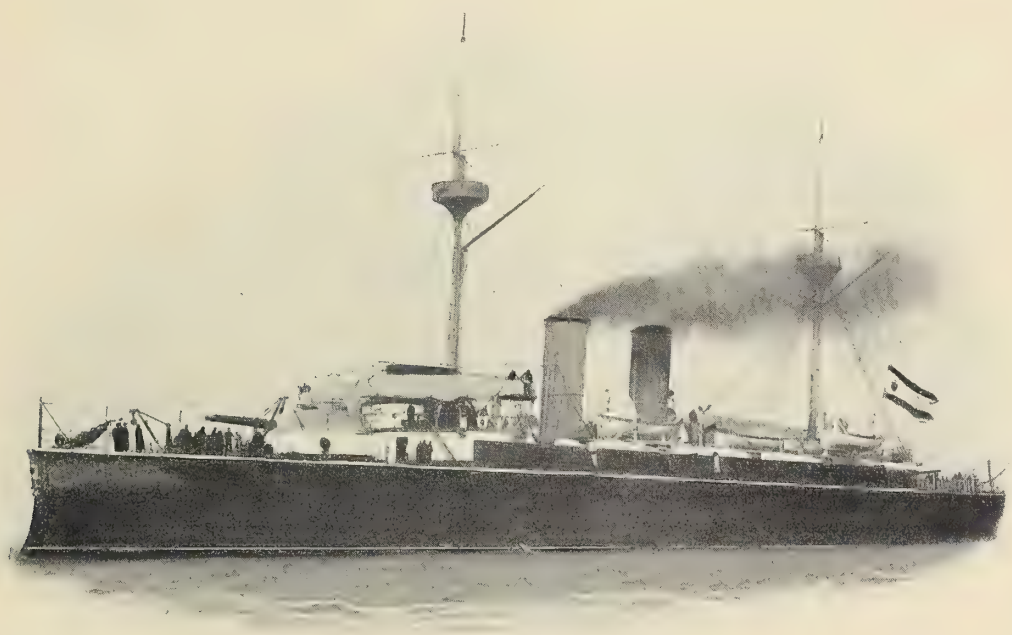
Diagram showing the increase of HOWDEN equipments by us for the first five years.



Vessels of the Spanish Navy Sunk or Captured by the American Blockading Squadron in the Sea Fight off Santiago, Cuba, July 3, 1898.

ARMORED CRUISER INFANTA MARIA TERESA, FLAGSHIP OF ADMIRAL CERVERA.

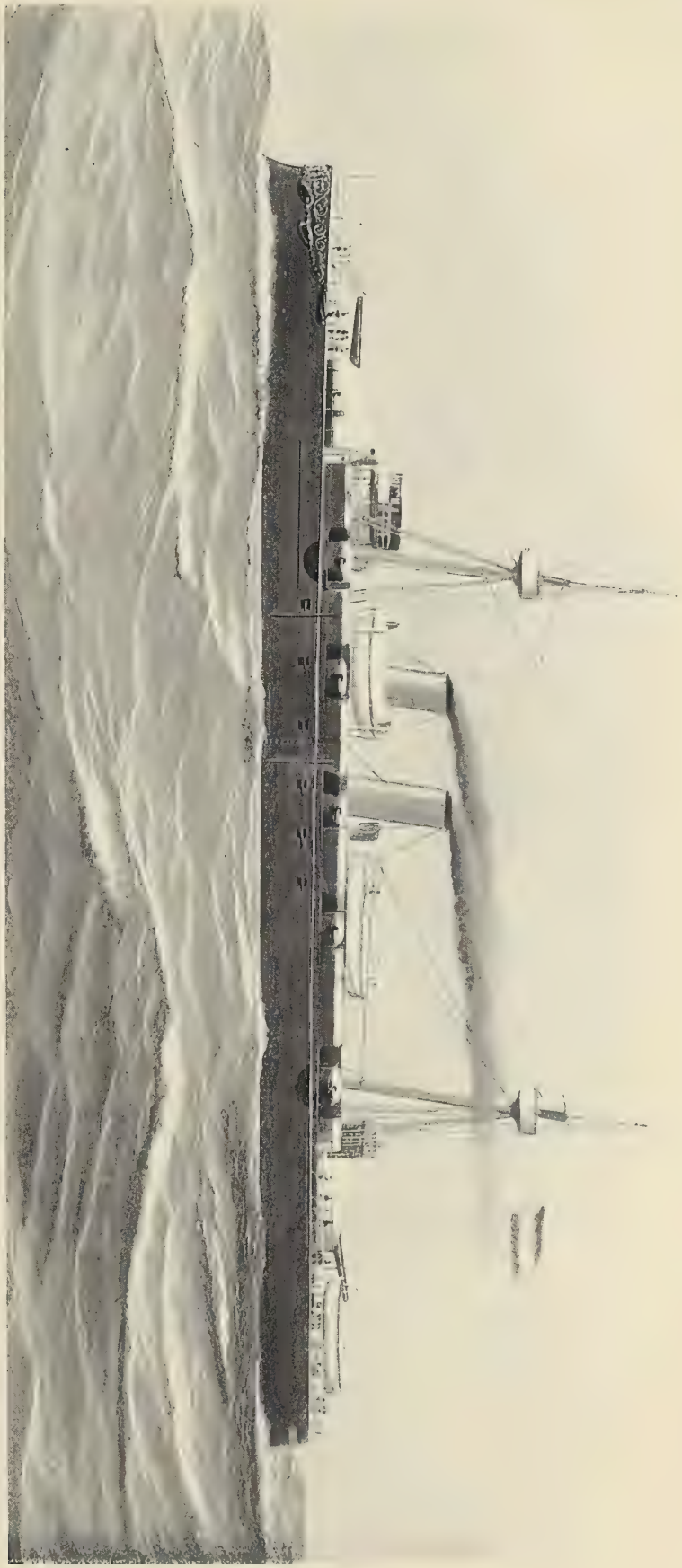
Photograph copyrighted by Johnson, N. Y.



ARMORED CRUISER VIZCAYA, AS SHE APPEARED RECENTLY IN NEW YORK HARBOR.

Photograph copyrighted by Johnson, N. Y.

FOR DESCRIPTION SEE PAGE 9.

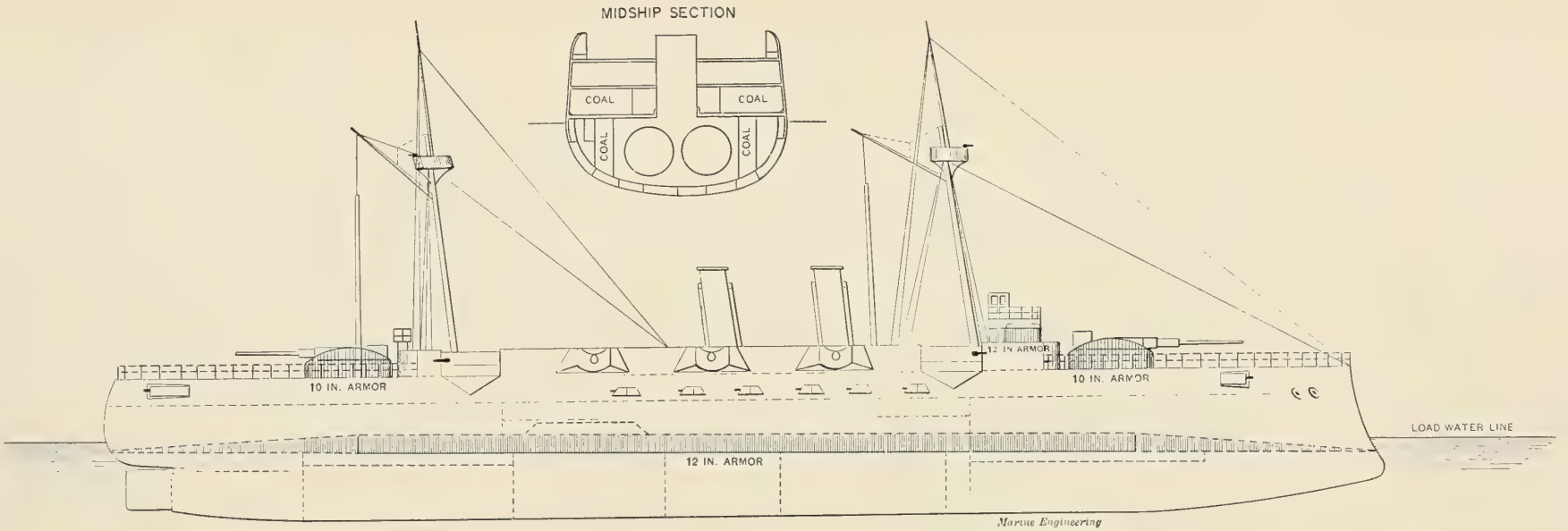


ARMORED CRUISER ALMIRANTE OQUENDO, WHICH, WITH THE VIZCAYA AND INFANTA MARIA TERESA, WAS BUILT AT BILBAO, SPAIN.

FOR DESCRIPTION SEE PAGE 9.

ARMORED BARBETTE CRUISER CRISTOBAL COLON, ORIGINALLY THE GARIBALDI, BUILT IN ITALY FOR THE ITALIAN NAVY.

FOR DESCRIPTION SEE PAGE 9.



DISPOSITION OF HEAVY ARMOR ON THE SPANISH CRUISERS ALMIRANTE OQUENDO, VIZCAYA AND INFANTA MARIA TERESA.

TORPEDO-BOAT DESTROYERS PLUTON AND FUROR, BUILT AT CLYDEBANK, SCOTLAND, FOR THE SPANISH GOVERNMENT.

FOR DESCRIPTION SEE PAGE 9.

LIBRARY
U. AUG 8 1898 S.
PATENT OFFICE.

MARINE ENGINEERING.

Vol. 2. NEW YORK, AUGUST, 1898. No. 8.

RECENT IMPROVEMENTS IN MISSISSIPPI RIVER FERRYBOATS AT ST. LOUIS.

BY WILLIAM H. BRYAN.

Upon western rivers the steel railroad bridge has largely replaced the ferry service of days past and has brought much fame to the civil engineer. For many reasons, principally commercial, there will, however, always be a large amount of passenger and freight traffic carried on in specially built ferry steamers. This is particularly true in large cities having important railroad terminals on the opposite shores, as is the case at St. Louis.

NEW DOUBLE-ENDED FERRYBOAT, THE ANDREW CHRISTY, IN SERVICE AT ST. LOUIS.

The service required of the ferryboat is peculiar. It differs widely from that of other river craft. The distance between opposite landings is usually small, and the run of but few minutes' duration. Fully as much time is consumed in loading and unloading as in running, so that the machinery is rarely in operation half the time, and only for short periods. The engines hardly have time to get thoroughly warmed up to their service when they are shut down. This, of course, precludes the highest economy.

The traffic also is peculiar. In many cities—New York for instance—there is a heavy passenger business, but in St. Louis this is quite small. Here by far the larger percentage of the work done is heavy teaming, although there are some lighter vehicles and stock. A considerable part of the coal coming to St. Louis is unloaded from the cars into large wagons in East St. Louis, and hauled across on the ferries. A great deal of St. Louis frieght, both east and west bound, is transferred in this manner.

The average daily business done by five of the Wiggins' Ferry Company's boats at St. Louis for a period of several months was 1,010 vehicles and 1,700 passengers. Averaging the former at 30 cents each and the latter at 3 1-2 cents, the

Copyright, 1898, by The Marine Publishing Co., New York.

revenue is:

For vehicles	$303.00 =	83⅓%
" passengers	59.50 =	16½%
Total	$362 50 =	100 %

Or an average for each boat of $72.50

All ferry service requires that loaded teams have ready access to and from the decks of the steamers, which requirement is met by specially constructed landing places or docks. At St. Louis movable wharf-boats are used, these being necessary on account of the great fluctuation of the water level.

The earliest type of river ferry was a raft propelled by poles. These, of course, could only be used on small and shallow rivers, and where the current was not swift. Later came the flat-boat, propelled by oars or sails, this being in time enlarged to accommodate a wagon and team. The earlier boats of this character were so small that the team was unhitched and the wagon taken apart, and even then several trips were sometimes necessary to transfer a single wagon, with team and load. These boats continued to be enlarged until they could accommodate a single team without unhitching. With increase of size came the necessity for more power. This was met by horse boats, which were quite common in the early days, and which are still in occasional use in out-of-the-way districts, and for very light traffic. Two forms of these boats were common: In one the horse worked a treadmill, and in the other he was hitched to a radial arm driving a central pinion to which the machinery was geared. The propelling wheels were located either at the side, center or stern. Blind horses were found preferable for this work. In some cases, where the river was not too wide, nor the current too swift, heavy ropes or cables were thrown across, and the boat made its trips by being fastened to this rope by a sort of trolley arrangement. Some of these were quite ingenious, the river's current against the deflected steering oar furnishing ample power to propel the boat to and fro across the stream. This arrangement was, of course, subject to frequent interruption—particularly where the river was subject to floods, and where there was much drift wood, or frequent passages of steamers.

Later came the pontoon bridge, a number of small flat-boats located side by side extending entirely across the river, the boats being well anchored in position, and provided with suitable decks and guards, the whole forming a continuous roadway. This arrangement was subject to all the difficulties of the last plan described, and has had but limited use.

With the invention of the steam engine and its successful application to vessels, the steam ferry came into general use. These vary widely in design and construction. They have, however, some important characteristics in common, viz., the requirement for large deck space, to accommodate numbers of loaded teams; the ability to handle themselves quickly and readily in crowded harbors, and to receive and discharge their cargoes with the least possible loss of time. Aside from these features their construction varies radically with the character of the streams on which they operate, the depth of water, the swiftness and direction of the current, its fluctuations in level, the distance between landings, etc. The type of machinery varies with the cost of the fuel, the character of the water required for the boilers and sometimes with peculiar local conditions of service.

The ferry in New York harbor is as different from that at St. Louis, as the characteristic Hudson river steamer is from that of the Mississippi. The New York ferry is a double ender, operating equally well in either direction. It has two pilot houses. Formerly they were all side wheelers, but this type has lately been superseded to a considerable extent by steamers with screw propellers at each end.

The ferry on western rivers, however, is quite different. Permanent docks cannot be used on account of the great fluctuation of water level, which is as much sometimes as 40 ft. or more. There is usually a speed of current of from 3 to 7 miles an hour in a fixed direction. Fuel is usually inexpensive, but the water available for boilers is often of the most objectionable character. Both the side and stern wheel types of steamers have been used to a limited extent for ferry service. The former has usually a large deck space forward and sometimes some space between the boilers and engines.

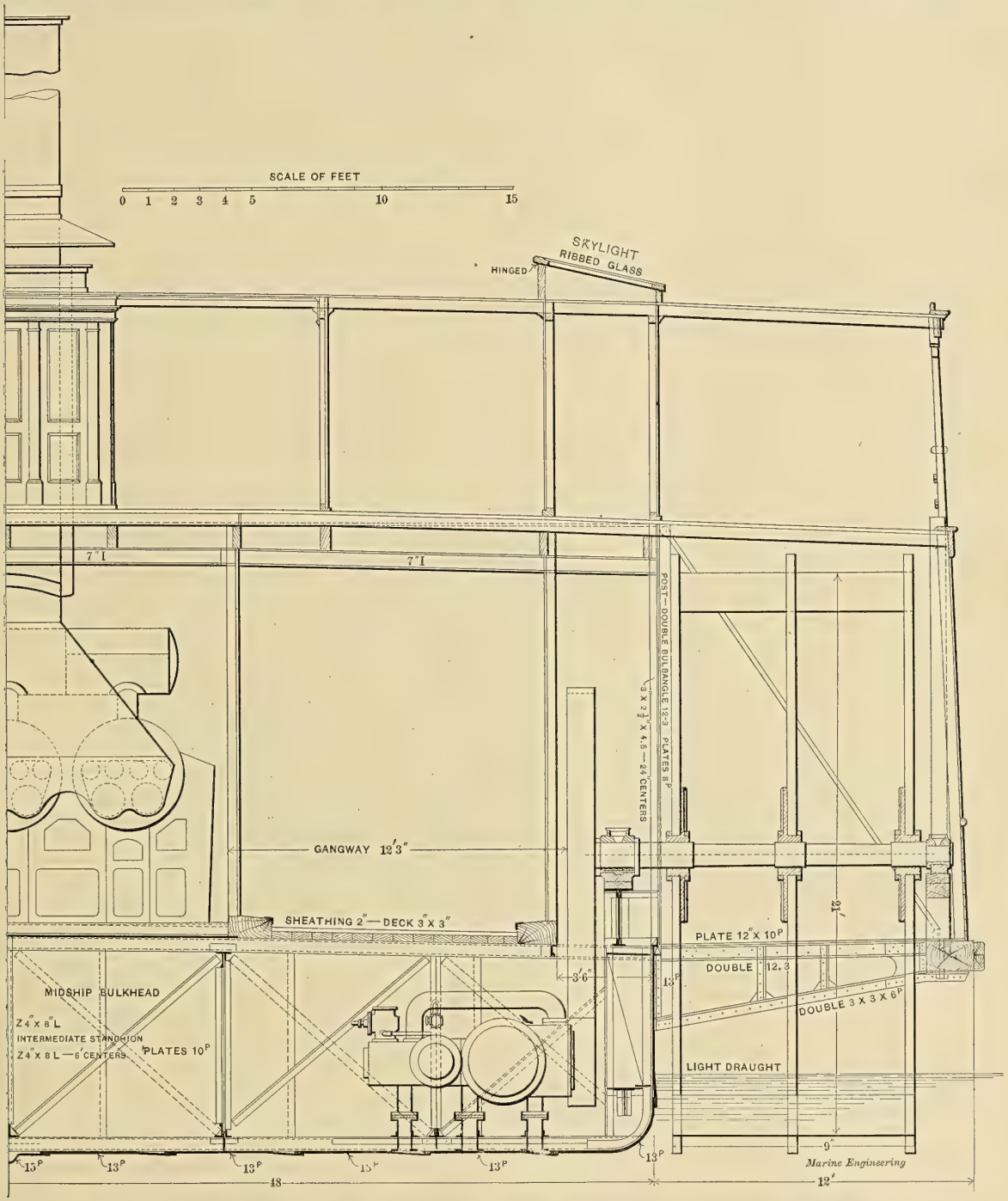
The characteristic type of western river ferry steamer, however, is the center wheeler, in which the hull is built with a central recess in the rear, in which the water wheel operates. This is known to old river men as the "catamaran" construction. Forward the hull is of the usual construction, but just aft of the center the central portion of the hull is cut away, leaving an open space. Back of this point, the hull is continued in two separate and independent divisions. Sometimes these are carefully modeled, both inside and outside, and sometimes only on the outside, the inner portion being left in plain vertical shape. The central wheel is of large diameter, working quite slowly, and is driven by a high pressure single cylinder non-condensing engine of the usual four valve lever type. The boilers are of the horizontal type common on western rivers, having long return flues. This type of ferry is well shown in the photograph on page 5.

While satisfactory in many ways this type of ferry is open to serious criticism in some respects—particularly in the matter of fuel consumed. The boiler used has an efficiency under 50 per cent., and the engines have a water rate of probably 40 lbs. per I. H. P. hour. In view of the fact that boiler efficiencies of 75 per cent are not uncommon now-a-days, together with water rates as low as 13 lbs., it can readily be

seen that there is a vast field open for fuel saving. The increased cost of fuel saving machinery, however, and the very low price at which fuel is bought in this market, have heretofore prevented much being done in this direction.

In the summer of 1896, the Wiggins Ferry Company, of St. Louis, engaged Frank E. Kirby, shortly thereafter. Ed. J. Howard, of Jeffersonville, Indiana, took the contract to build the hull and cabin, and the Detroit Dry Dock Company, of Detroit, Mich., to furnish and erect the engines.

Actual construction continued from February to September, 1897. The hull was built at Jefferson-



HALF CROSS SECTION OF MISSISSIPPI-RIVER FERRYBOAT, ANDREW CHRISTY.

of Detroit, Mich., as their consulting engineer, to design a new ferry steamer on more modern lines. Mr. Kirby completed the design in October, 1896, and contracts were let for the work

ville, Indiana, but on account of threatened low water was taken to Cairo, Illinois, for completion. She was practically finished at this point, but it was thought best to tow her to St. Louis,

and she reached this city on September 15, 1897. Here the finishing touches were put on, and she was examined by the U. S. inspectors, and began regular service September 26. This steamer, which was named the Andrew Christy, first went into regular service on a new route established between the foot of North Market street, St. Louis, and the C. & A. Ry. Depots, East St. Louis, a distance of a little over a mile in a direct line. Here she made twenty-six round trips a day, operating between 6 A. M. and 7 P. M., making half-hourly trips. This route proving unprofitable, however, it has been discontinued, and the "Christy" has been put into service on one of the company's old routes, from the foot of Carr street, St. Louis, to the C. & A. Ry. Depots, in East St. Louis. Here she displaced two of the company's old style steamers, doing the same work with only one crew, and with only the fuel consumption of one boat.

The "Andrew Christy" has been specially adapted for excursion service, having very roomy upper decks. It is proposed to make a specialty of this service by issuing tickets at 10 cents entitling the holder to remain on the boat as long as he desires.

The accompanying engravings give full particulars of the construction of this steamer. It will be seen that she differs materially from the characteristic Mississippi river ferry. In the first place her hull is of steel, instead of wood. The boat is a double ender, and a side wheeler. Her deck arrangement is quite different from the ordinary type. The hull is 176 ft. long between perpendiculars, and 7 ft. deep. Her beam is 48 ft., which added to the 12 ft. guards, makes a width of 72 ft. over all. The steel hull plates are 5-16 in. and 3-8 in. thick. The framing is made of 6 in. 13 lb. bulb angles, spaced 20 in. The beams are of 6 in. bulb angles, with centers 20 in. and 24 in. There are three fore and aft trusses; and no hog chains whatever. The weight of steel in the hull is approximately 215 tons. It was expected that the draught of the boat, with coal and water on board, would be 3 ft., but she actually trims on a little less than 30 in. Her launching draught was 16 in.

There are three water tight bulkheads, extending from side to side, one located amidships, and the others near each end. The hull coefficient, is 75 per cent. There are five athwartship truss frames, in addition to the three water-tight bulkheads. The hull construction—which is the same at both ends—is very full in body, and the boat appears to ride over the water, instead of cutting through it. There is a keel of 15 lbs. shaped steel, projecting 3 in. An independent rudder is of course fitted at each end, each controlled from the pilot house at the opposite end.

The engines represent the most radical departure from ordinary Mississippi river practice. Each side wheel is controlled by an independent non-condensing horizontal geared engine located in the hold. These are of the cross-compound type, with high pressure cylinders 16 in. dia., low pressure cylinders 32 in.; stroke 24 in. The pistons have metallic packing, and the piston rods are of steel. The speed in regular operation varies between 75 and 125 revolutions per minute, and is ordinarily kept between 80 and 90. The engines are of the reversing type, the valves being actuated by the ordinary Stephenson link notion, the operating levers being located in the engine room on the main deck. The levers controlling both engines are located on the main deck, side by side, just back of the boilers, and are handled by a single engineer, with great ease and promptness. There are three levers for each engine, one operating the link-motion connected to both high and low pressure valves, one for throttle, and the third controlling a pipe which admits high pressure steam into the low pressure cylinders to throw the engine on center when this is necessary. Piston valves are used on the high pressure cylinders, and double ported slide valves on the low pressure cylinders.

The crank shafts are of the built-up type 6 1-2 in. dia., and are set 90 deg. apart. The cranks are of cast steel, 5 in. thick. As the engines themselves are not visible from where the engineer stands, tell-tales are provided to indicate their motion. There is considerable vibration, particularly on the upper decks, and at full speeds, although the engines are usually worked slightly out of step to reduce this. The vibration is due principally to the spacing of the buckets of the wheels which are pitched wider than usual, in order to make her a powerful ice breaker. The engine crank shaft is geared by means of a 3 ft. pinion with a 12 ft. spur wheel on the side wheel shaft. These gear wheels are made of gun iron, machine moulded by Poole, of Baltimore. They make considerable noise—particularly when stopping or reversing, as the teeth are not cut. Some fear has been expressed that these gears might break, but investigation shows that they are performing similar service elsewhere with satisfaction. Three advantages result from the use of gearing: deck space is economized, weight is reduced, and a higher piston speed permitted, the latter being necessary for good steam efficiency.

The ratio of speed between engine shaft and side wheel being four to one, the normal speed of paddle wheel is between 20 and 30 revolutions per minute, averaging probably about 22. The water wheels are 21 ft. outside dia., with 14 buckets each 9 ft. long by 18 in. wide. The wheel shafts are of hammered iron, 11 in. dia., at their largest dia. and 7 in. at the smallest. There are three wheel centers on each shaft as will be observed in the cross section on page 3.

The cut-off in the high pressure cylinder is, of course, adjusted by the link motion, the latest point being about three-quarters. In ordinary

service, however, the cut-off is about one-half in this cylinder.

The engines described above are more powerful than are ordinarily placed on boats of this size. This increase was made with a view of making her particularly effective when operating in floating ice, and the anticipations have been fully realized in service.

The steam connections to each engine are 4 1-2 in.; exhaust 8 in., the two combining into one 10 in. passing through the exhaust head and pipe on upper deck. Although an open heater is used no trouble has been experienced with oil in the boilers. There is but small receiver capacity, and no reheating coils.

The boilers are of the ordinary river type, three in number, all set in one furnace, with the usual river setting of sheet iron lined with brick. Dimensions as follows: 48 in. diameter, 28 ft. long; 6 flues, two being 13 in. and four 8 in.; grates 5 ft. long by 14 ft. 2 in. wide; heating surface, 1,977 sq. ft.; grate surface, 71 sq. ft; ratio 1 to 27.85. This is a very small ratio, but not smaller than is common with boilers of this type which it is frequently necessary to "crowd" far beyond their rating. In view of the fact, however, that the boilers steam easily, it would probably be safe to cut down the grate surface a little, particularly if artificial draft is secured by turning the exhaust into the stack, which is not the case now. The rated horse power of these boilers at 8 sq. ft., is 247, but they are undoubtedly worked far beyond this frequently.

The boilers are cleaned internally every second Sunday, and externally about once a week. They are allowed a pressure of 157 lbs. and usually carry about 145 lbs. The thickness of the shells is .29 in.; with longitudinal seams double riveted; and rivet holes drilled. The material is 65,000 lbs. tensile strength steel.

Two improvements are noticeable in these boilers which undoubtedly make them more economical than the ordinary river boiler, viz: the use of smaller tubes, and greater length of shell. The chimney is of steel, of the usual construction, 50 in. dia. and about 40 ft. high above grate level. Natural draught only is used, and the direction of the operation of the boat seems to make no difference in the steaming qualities of the boilers. The estimated weight of the boilers, engines, and water, is 150 tons.

The auxiliary machinery is neither complicated nor elaborate. The boiler feed apparatus consists of a large "doctor" of the usual Mississippi river type, with two cold water plungers 5 3-4 in. dia., two hot water plungers 4 5-8 in. dia., and stroke 14 1-2 in.; all single acting. One side of this "doctor" pumps cold water from the river, and discharges it into the open heater overhead, from which it is taken by the other side of the "doctor," and forced into the boiiers. The fresh water entering the heater passes through a coil before being discharged. As more water is pumped into the heater than is taken out, there is a constant overflow into the suction pipe, which warms the entering water to some etxent. As these "doctors" are liable to stick on the center it is frequently necessary to by-pass part of their

OLD TYPE OF MISSISSIPPI-RIVER FERRYBOAT WITH CENTER WHEEL, AT ST. LOUIS.

capacity in order to keep them moving, so that there is considerable waste of energy. On the "Christy" injectors serve as reserve feeders.

There is a large fire pump, and a direct connected electric lighting plant of 4 Kw. capacity, there being 78--16 c. p. lights wired on the boat. The generating unit consists of a Westinghouse engine and a Fuller dynamo.

In operation this steamer has given most satisfactory results. No tests have been made, but as nearly as can be estimated she burns about 50 per cent. less fuel than the other Wiggins steamers. She is also much faster, and it is claimed that she is the fastest steamer in the St. Louis harbor. On timing her on one trip from East St. Louis to North Market street, she covered the distance in 8 1-2 minutes, being run slow part of the time on account of shoal water, and at no time at full speed. This would be equal to about 7 miles per hour against the current, which was running probably 3 miles, a total of 10 miles per hour. It would seem therefore that she can easily make 12 miles should occasion demand. She is not operated usually as a double ender, as it involves some complication in the handling, and is furthermore found unnecessary. She does not handle quite as well with the rudder as the other boats, but the steering facilities afforded by the two side wheels make it possible to handle her with much greater ease, and she can be turned in considerably less than her own length. In practice, one of the rudders is kept permanently pinned in place, and only one pilot house is used.

The decking and upper works of the boat are constructed of wood in the usual manner and are very complete. The weight of the entire woodwork is estimated at 150 tons.

As might have been expected, the design of this ferryboat was not looked upon with favor by the old time river men, but her fine performance has in a large degree silenced criticism.

Negotiations are now pending for the construction of one additional boat of the same general character. If any changes are made they will be in unimportant details, such for instance, as using steam steering gear, operating both rudders from one pilot wheel, and adding one arm to each side wheel. Some changes may also be made in the hull model to improve the steering. It is possible that surface condensers may be applied to the next boat. These will furnish distilled water to the boilers, so that the latter may be of much more efficient type, occupy less space, and in all probability be located in the hold, thus leaving more deck room for traffic. There is room for doubt, however, as to whether the fuel bills will be reduced sufficiently to warrant the additional first cost, greater complication of parts, and liability to derangement, increased weight and space occupied. Fuel is quite cheap at St. Louis, the engines are in operation but a small fraction of the time, and rarely under conditions favorable to the highest economies.

In the following table there will be found some comparative figures on the Andrew Christy and the Alonzo C. Church, which is a fairly representative steamer of the type heretofore employed by the company.

The exact cost of the Christy could not be secured, but it approximated very closely to $50,000. The iron hull and wood work cost about $30,000. The cost of the ordinary wooden hull ferry steamer is a little over $30,000.

COMPARISON BETWEEN WIGGINS FERRY STEAMERS.

	Alonzo C. Church.	Andrew Christy.
When built	1893	1897
Length	172 ft. 3 in.	178 ft.
Beam	43 ft. 3 in.	48 ft.
Depth	6 ft. 5 in.	7 ft.
Tonnage, net	332.62	522.92
Material of hull	Wood	Steel
Draught	42 in.	29 in.
Boilers—Number	3	3
Diameter	46 in.	48 in.
Length	18 ft.	28 ft.
Number of flues	6	6
Diameter of flues	2-13 and 4-7 in.	2-13 and 4-8 in.
Heating surface	1,196	1,977
Thickness of shell	.26 in.	.29 in.
Pressure allowed	147 lbs.	157 lbs.
Engines—Number	1	2
Type	Simple	Compound
Diameter cylinders	28 in.	16 in. and 32 in.
Stroke cylinders	72 in.	24 in.
Steam pipe, diameter	7 in.	4 1-2 in.
Estimated horse power	400	500
Average speed, revolutions per min.	15	80
Approximate cost of completed steamer	$35,000	$50,000

Both steamers were built at Jeffersonville, Ind. The engines of both are horizontal, non-condensing. The boilers are all of the ordinary horizontal return flue type, externally fired.

MARINE GASOLINE AND GAS ENGINES AS USED IN MODERN MOTOR BOATS.—II.

BY CECIL H. PEABODY, M.E.

In the first article of this series the general principles of gas engines and the conditions which control their efficiency were discussed. We will now consider some of the operations which are essential to the running of all such engines, and which consequently control the design of gasoline engines used for propelling boats and motor carriages.

Fig. 1 of the first article (repeated here for convenient reference) represents the indicator diagram taken from an engine using kerosene oil, but since there is no essential difference in diagrams taken from explosive engines, whether they are gas, gasoline or oil, it may be considered to be the typical diagram for all recent internal combustion or gas engines. Four strokes are required to complete the cycle. The first stroke represented by *a b* draws in an explosive mixture of air and gas or vapor; the second stroke compresses this mixture as represented by *b c*. After the compression is complete the mixture is ignited and there is an explosion or sudden rise of pressure represented by *c d*. The next stroke, represented by *d e* is the expansion or working stroke. At or near the end of the stroke the gases are released as represented by *e f*, and the fourth stroke *f a* ex-

pells the spent gases from the cylinder. When all these operations are performed, in one cylinder, two complete revolutions of the engine and four strokes of the piston are required to complete the cycle. Of the four strokes only one is a working stroke; two strokes are transfer strokes, during which the gases operated on are drawn into or expelled from the cylinder; one stroke,

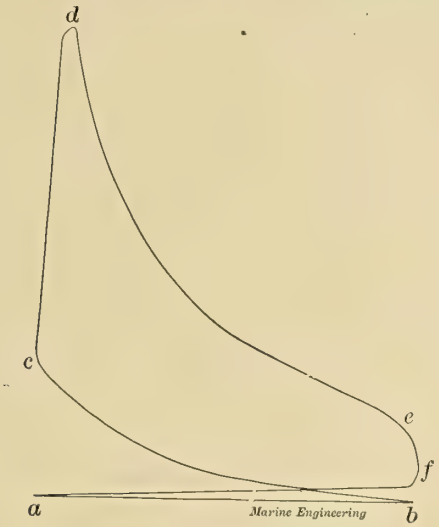


FIG. 1.

during which the charge is compressed, must be made at the expense of power taken from the fly wheel of the engine. We now see why so large a fly wheel is required for engines of this type. Almost all stationary engines, have all four operations performed in one cylinder, as a large fly wheel, and a massive foundation are readily supplied to such engines. Some large stationary engines have two cylinders and thus, by alternating the explosions, can get one working stroke for each revolution of the engine. A 400 horse power gas engine at Godalming, England, has four cylinders and can have two explosions for each revolution, so that it compares favorably in regularity of running with a steam engine.

When internal combustion engines shall be employed for propelling ships, it will probably be found advisable to use four or more cylinders with their pistons connected to a single propeller shaft, but the reduplication of parts and consequent complication appear to be inadmissable for small boats. For this reason many gasoline engines have the transfers represented by the line *f a* and *a b* Fig. 1, performed by a separate piston, or what amounts to the same thing, by the under side of the working piston.

Fig. 3 shows how this is done by the Sintz gasoline engine. The crank end of this engine is enclosed and forms a reservoir for the explosive mixture of air and gasoline vapor. On an up stroke of the piston the air and gas are drawn in, and on the next down stroke they are slightly compressed by the under side of the piston. The engine has no valves, the flow of gas to and from the cylinder being controlled by the piston itself. For this purpose there are two sets of ports cut through the cylinder walls near the lower limit of the stroke of the piston head. The port on the left side is for the exhaust of spent gases, as indicated on the figure; the port on the right is for the admission of a fresh charge. On the down or working stroke the piston overruns first the exhaust port at the left, and the spent gases which have a pressure considerably higher than that of the atmosphere, escape through the exhaust pipe. After the release is nearly completed, the gases from the crank end, previously compressed by the under side of the piston, flow in through the port at the right hand, as indicated by the arrow, and displace the remaining spent gases. The piston consequently does not need to make the transfers and can have a working stroke for each revolution of the engine. Each up stroke is a compression stroke, and each down stroke is an expansion or working stroke.

The method of removing the transfers from the duty of the working piston, gives at once the advantages, that the power of the engine of a given

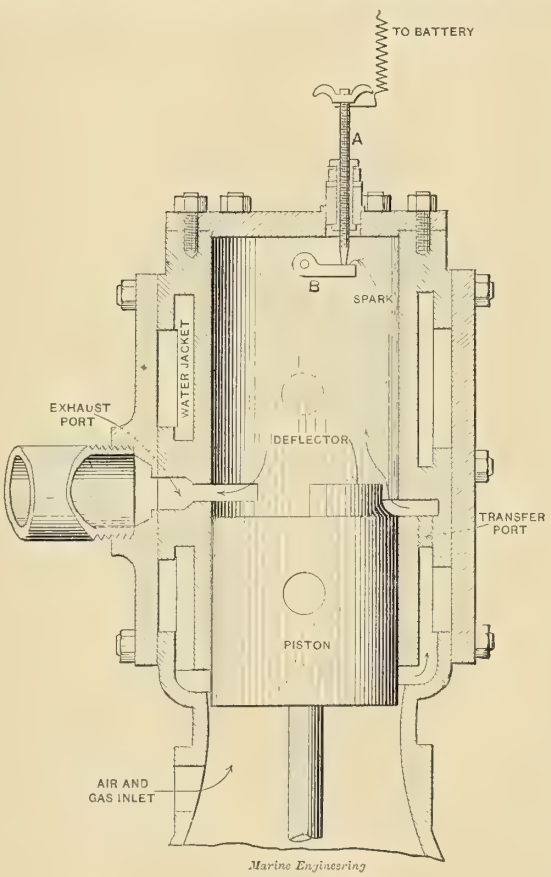


FIG. 3.

size is doubled, and the steadiness of running is much improved. And yet, a single cylinder engine of this type will require a fly wheel of considerable size and weight.

Unfortunately the advantages gained by taking the transfers of gas away from the working piston are likely to be modified, because the incoming fresh charge, instead of sweeping the spent gases entirely out of the cylinder, mingles with them more or less. In some cases the fresh gases may even get as far as the exhaust port before the spent gases are properly expelled, and escaping unburned, may lead to a direct loss. The makers of the Sintz engine, realizing this danger, have placed a deflector on the piston which throws the incoming fresh charge toward the upper end of the cylinder. This engine has incidentally the advantage that no valves are required for controlling the flow of gas into and out of the cylinder.

It may be pointed out in passing that a two-stroke motor like the Sintz engine would need two cylinders to give as much regularity of running as a single cylinder steam engine; and that four cylinders would be required to give the equivalent of a two crank steam engine.

One of the most important devices for a gas engine is the igniting arrangement. Three types of igniting arrangements have been used for gas engines: (1) The flame ignition, (2) the hot-tube ignition, (3) the electric ignition. The flame ignition does not appear to be well adapted to use on boats and will be dismissed with the statement that it consists essentially in carrying a burning mass of gas and air into the cylinder of the engine at the proper instant. The mass of gas must of course be ignited by a flame or gas jet outside of the engine, and must be carried in a closed space on the way to the cylinder. To keep the flame alive in this closed space and to raise the pressure so that the flame shall not be blown out when communication is opened with the cylinder, some of the compressed combustible charge from the cylinder is allowed to leak into the flame chamber on the way to the cylinder.

The hot tube igniter is represented in Fig. 4, as it was first used on the Atkinson engine. It consists simply of a wrought iron tube (1) communicating with the interior of the engine cylinder (4) and closed at the outer end. The tube is kept at a red heat by a Bunsen flame (2) which is enclosed by a non-conducting shield (3) to protect it from draughts and to reduce radiation. The Atkinson engine to which this was applied was so constructed that the piston uncovered the opening of the pipe to the cylinder at the proper time. In engines of the ordinary type a valve must be provided to open communication with the cylinder when the explosion occurs, and further it is customary to provide a separate exhaust for the tube, so that it shall be sure to be filled with fresh gas for each ignition.

Very curiously we find that both the earliest and least reliable, and the most recent and approved igniting arrangements are electrical. The earlier type had a pair of platinum points carried

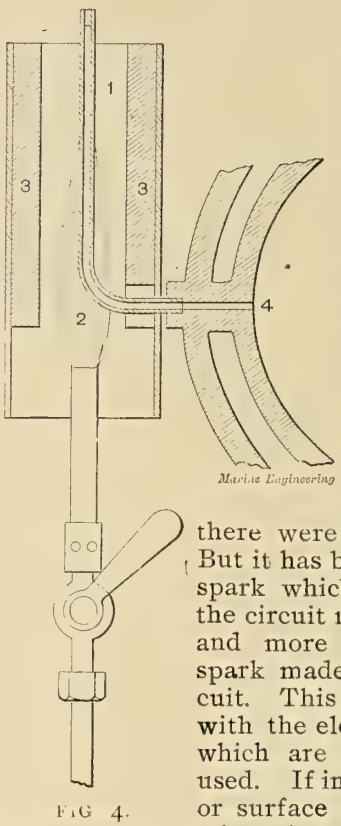


FIG 4.

through an insulated plug into the engine cylinder. A primary battery and a Ruhmkoff coil were provided to produce a spark between the points when the circuit was closed by a mechanism that was driven by the engine. Nothing seemed more simple; but it was found that the spark was both feeble and uncertain, and that there were frequent misfires. But it has been found that the spark which is formed when the circuit is opened, is longer and more intense than the spark made by closing the circuit. This is very noticeable with the electric gas lighters, which are now so commonly used. If in addition one point or surface is drawn over the other when the spark is formed both surfaces are kept bright and in good condition. The spark thus formed is known as a "wiped spark." The acting points or surface must of course be inside the engine cylinder, which leads to somewhat more complication than was necessary with the older device.

The igniting device for the Sintz engine is shown by Figs. 3 and 5. In Fig. 2 A is an insulated adjusting screw which receives one wire as indicated. B is a lever which receives motion through an axis or spindle that comes through the side of the cylinder. At the proper time B is swung down, and produces the spark for igniting the charge. Of course there is a spark when the circuit is closed, but it is feeble and does not ignite the charge. On the engine shaft there is an eccentric which drives a pump for circulating water through the water jacket, and also operates the igniting arrangement. The eccentric rod drives a rod as shown at E F, Fig. 5. This rod D carries a projecting ring G which strikes against the steel point L on a cast iron casing J. This casing is connected to the rod or spindle H which carries the lever B, Fig. 3, not direct, but through a clock spring. When the eccentric rod is down the clock spring throws the casing around to the right till it is arrested by the stop M; when the eccentric rod comes up, the ring G strikes the point L and revolves the casing J to the left and raises the lever B (Fig. 3) till it strikes the point A; then the casing J goes on and winds up the spring until

the point L slips off the ring G, whereupon the casing and the lever B are thrown around to the right by the spring, first breaking contact and forming a spark between A and B, and then coming to rest against the stop M.

Another very important question concerning gas engines is the method of controlling or governing them. The standard method for governing stationary engines is by omitting an occasional explosion. This is accomplished by drawing back the cover which opens the gas supply so that it fails to act. The consequence is that the engine draws in air without an admixture of gas, and though all the other operations are performed in regular order, including one attempt at ignition, there is no explosion, and no power is developed. Such a method, as compared with the easy and nice regulation of a steam engine, appears to be very crude. It has the advantage that every working cycle is made at full power and efficiency; in fact, the working cycle following a blank cycle is more than usually efficient. Of course a two cylinder, and still more, a four cylinder engine, shows less fluctuation of speed, on account of regulation by omitting a working cycle, than is found for a single cylinder engine.

Some attempt has been made to adjust the power of a gas engine by controlling the proportion of gas and air, but since gas engines work most efficiently with poor or weak mixtures of gas and air, and since too weak a mixture will

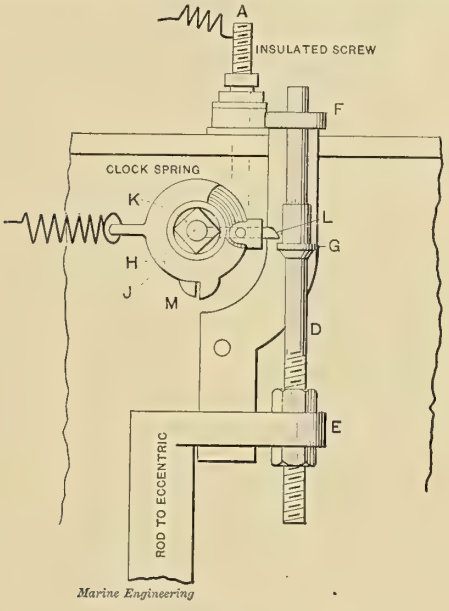


FIG. 5.

fail to explode, it is evident that this method cannot be relied upon for governing an engine.

There remains now one more way of controlling a gas engine, and that is by throttling the combined gas and air supply. The result of this method is to draw in the gas and air supply at less than atmospheric pressure, and consequently there is a marked reduction in power. In the first place there is less fuel introduced into the cylinder, and consequently less heat is produced by the explosion, and in the second place the mixture has a low pressure at the beginning of compression and a relatively low pressure at the end of compression, which of itself directly reduces the power of the engine. Some engine builders claim that their engines are as efficient at low power as at high power, when controlled by this method, but it is difficult to see how this may be. Unfortunately but little disinterested testing of gasoline engines has been done thus far, and many builders of such engines consider that their interests are served by reticence concerning both the construction and operation of their engines.

DESCRIPTIONS OF THE SPANISH VESSELS DESTROYED AT SANTIAGO JULY 3.

In the supplement with this issue we present several original views of the Spanish vessels captured or destroyed by the American blockading squadron at Santiago, July 3. Our readers are of course familiar with the story of the fight, which the press of the country has published, not only from the correspondents at the front but from officers and men on the ships who participated in the battle. The vessels destroyed included the pick of the Spanish navy, each one a magnificent ship representing the highest development of scientific effort in her class.

The Cristobal Colon, as readers of our April issue will recollect, was an armored cruiser of about 6,800 tons displacement. She was built recently at the Ansaldo yard at Sestri Ponenti for the Italian Government, to be called the "Guisippe Garibaldi," but shortly before the war sne was purchased by the Spanish Government and renamed. Her dimensions were: length, 328 ft.; beam, 59 ft. 9 in., and mean draught, 23 ft. 3 in. In general appearance she resembled somewhat vessels of our battleship class. One peculiarity of her construction was the location of her military mast between the funnels, which were spaced in a fore and aft direction. This caused the quick recognition of the vessel by our sailors when she emerged from the harbor of Santiago on July 3. Her offensive powers were very strong for a vessel of her dimensions. A 9.84-in. rifle was placed in each end barbette, giving a wide angle of fire; ten 5.9-in. rapid-fire guns were carried also in the main battery, five on each side. These guns could be trained ahead or astern in a considerable arc, as well as used for direct broadside fire. Besides these guns, in the secondary batteries, there were six 4.7-in. rifles, ten 6-pounders, ten 1-pounders, all rapid firers, and two Maxim automatic machine guns. There was very ample protection, too, for the vessel and gunners. She had a complete Harveyized steel belt 6 in. thick and 8 ft. 3 in. wide, about the water line and above this the protection was carried to the upper deck for a distance of 120 ft.

amidships. The bases of the barbettes of the bow and stern chasers were protected by 6-in. steel bulkheads, and the barbettes themselves were 5 in. thick. The protective deck ranged in thickness from about 3-4 in. to 1 1-2 in. and the deck above the central batteries was nearly 2 in. thick. There were also four torpedo tubes for Whitehead torpedoes. Many special electrical devices were employed for the rapid manipulation of the guns. These included training and loading gear for the 9.84-in. guns and for the several ammunition hoists, and for this reason the generating plant was quite extensive.

The propelling machinery consisted of two sets of triple-expansion engines driving twin screws. The engines had cylinders 42 in., 63 in. and 97 in. dia. by 46 in. stroke. To secure lightness and strength steel was used extensively in the construction of the engines, including the frames and bed plates. Piston valves were fitted to the high pressure cylinders and double-ported slide valves to the intermediate and low pressure cylinders. The engine motions and shafting were hollow steel forgings. The main condensers were of delta metal, with a cooling surface of 14,600 sq. ft. The air pumps were 33 in. dia. by 21 in. stroke and were direct driven off the low-pressure crosshead. A complete system of hot feed was part of the auxiliary equipment. Steam was supplied by twelve water-tube boilers of the Niclausse type, built in France. They were placed in two groups of six each, divided into sections of three by water tight compartments. The boilers were set back against the fore and aft bulkhead, and, as will be noticed in the drawing on page 11, they were placed both forward and abaft the engines and higher up in the ship than is usual. With steam pressure of 145 lbs. and nearly 100 revolutions, the engines indicated, collectively, 10,700 horse power. On trial a speed in excess of 19 knots was attained with natural draft, and at sea, in good trim and with a clean hull, a rate of speed of about 17 knots could be easily maintained. With forced draft and for spurts this could be largely exceeded.

The bunker capacity of the Cristobal Colon was 600 tons, but in case of emergency she could carry 1,200 tons, and there was provision for carrying liquid fuel in the double bottoms. Her complement was 500.

Our artist has represented the Cristobal Colon with her big guns mounted fore and aft, showing the vessel fully equipped. According to reports from the American squadron these guns were not in place during the Santiago fight. The cause of their absence is said to be a delay in carrying out the tests of this portion of the armament, so that the warship had to sail without a complete main battery.

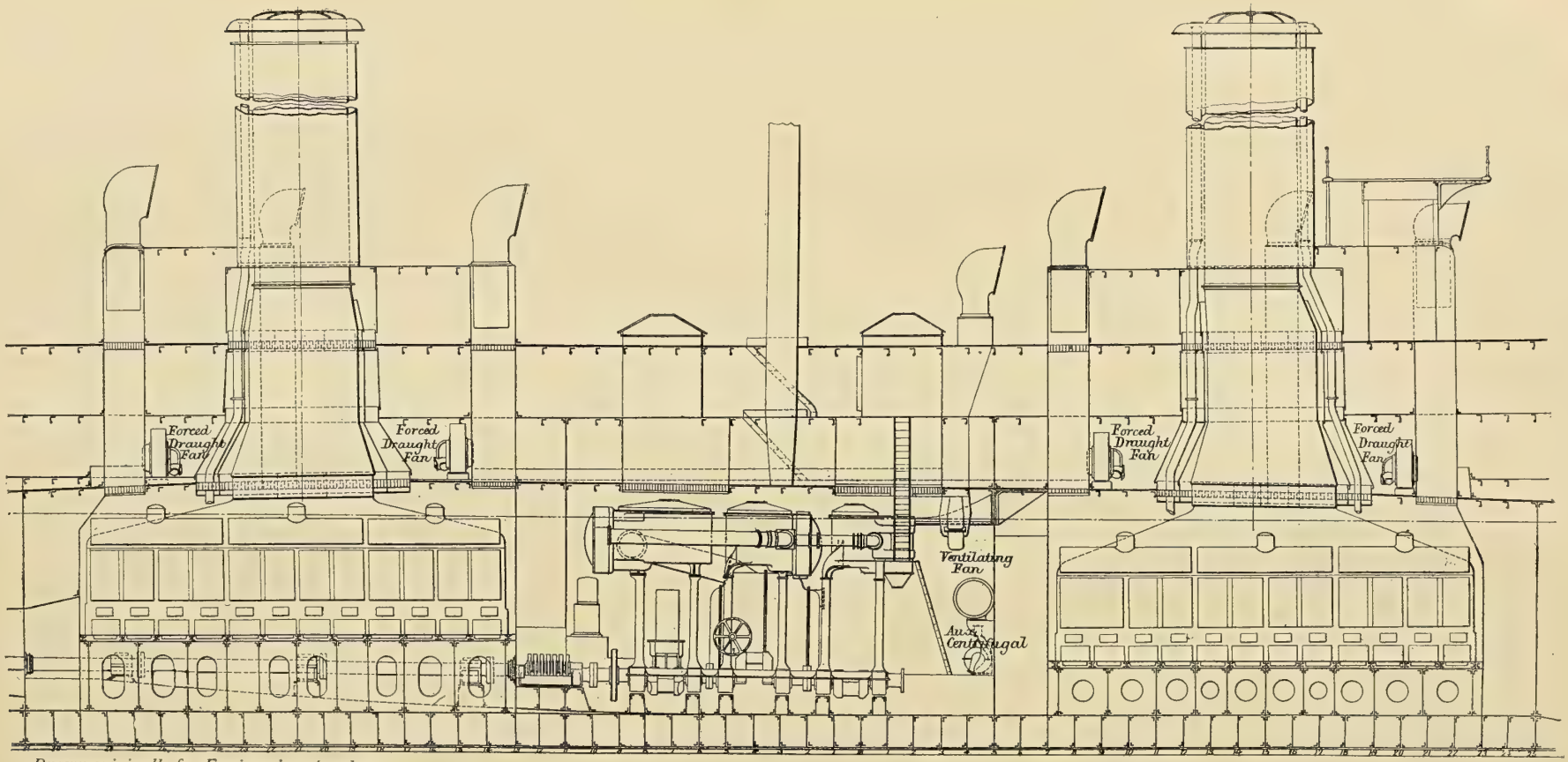
The other three ships destroyed by our fire were classed as armored cruisers with barbettes. They were alike in general dimensions and equipment, differing only in minor details, many of which were introduced since the ships were in commission. Their names and dates, according to the time of launching, were, Infanta Maria Teresa, 1890; Vizcaya, 1891, and Almirante Oquendo, 1891. Many of our readers will recall having seen the two first named, the "Teresa" at the Columbian Naval Review in the North River in 1892, and the "Vizcaya" at the Staten Island anchorage in the upper bay at New York early this spring, on which occasions the photographs reproduced in our supplement were taken. They were twin screw vessels of 7,000 tons displacement, each fitted with two smoke pipes and two masts with fighting tops. They were built at Bilbao, in Spain. The chief dimensions were: length, 364 ft. over all, 340 ft. between perpendiculars; beam, 65 ft. 2 in., and mean draught, 21 ft. 6 in. They were protected with heavy armor, disposed according to the shaded portions shown in the drawing in our Supplement. Armament of each consisted of two 11-in. Hontoria breech-loaders mounted singly in turrets forward and aft, ten 5.5 in. Hontoria rapid firers, mounted five on each side, eight 6-pounder and ten 1-pounder rapid-fire guns and several machine guns. Each was fitted with six torpedo tubes, with both above and below water discharge.

Armor included a 12-in. steel belt at the water line, 5 ft. 6 in. wide, 12-in. steel on the big-gun turrets and 8 in. glacis plates over the engine room, 12 in. protection for the conning tower and a protective deck ranging in thickness from 2 in. to 3 in. Coal bunkers were interposed between the sides and vitals, according to the usual practice, giving additional protection from machine gun and secondary battery fire.

The engines were of the usual inverted triple expansion type, developing 9,500 horse-power with natural draft and 13,000 with forced draft. The corresponding rates of speed were 18 1-2 knots and 20 knots. Steam was raised in six Scotch boilers, four double-ended and two single-ended. Coal capacity for 1,050 tons was provided, sufficient to carry each vessel nearly 10,000 miles at 10 knots speed. The cost of each vessel's hull and machinery was $3,000,000.

These ships were of a very handsome model, and when properly painted and cleaned, were unusually fine looking specimens of naval architecture. The rake of the masts and stacks and the neatness of design of the upper works, combined with the symmetrical hull lines, made a very pleasing and elegant combination.

Of the vessels of the Spanish squadron there now remain to be described the torpedo-boat destroyers Furor and Pluton, the destruction of which was even more complete than that of the larger vessels. These boats attracted probably more attention in professional and lay circles, previous to the fight, than the big cruisers. This was because their effectiveness was so largely a matter of conjecture until they sank as impotent wrecks in Cuban waters. While of the familiar



Drawn originally for Engineering, London.

LONGITUDINAL SECTION OF THE SPANISH CRUISER CRISTOBAL COLON, THROUGH ENGINE AND BOILER ROOMS.

destroyer type, they were of unusual dimensions, or considerably larger than the boats in service in other navies. Both were a product of the famous Thompson Works at Clydebank, Scotland, the builders who turned out the former American liners New York and Paris, now the cruisers Harvard and Yale of our navy. The Furor was launched in 1896 and the Pluton in 1897. They were very similar in size and dimensions, the Pluton being slightly the larger of the two. The Furor measured 220 ft. in length, 22 ft. beam and 5 ft. 6 in. draught, and was of 380 tons displacement. She was fitted with twin-screws driven by four-cylinder triple-expansion engines located in a compartment abaft the boilers. Steel was extensively used in their construction, not only in the frames but the cylinder tops and bottoms, pistons and all rods; also the bed-plates and the crank, thrust, and propeller shafts. Hollow forgings were introduced wherever possible. The piston-rod heads and guides were forged solid with the rods, and the crosshead pins were carried fixed in the connecting rods. On the ahead side the guides were filled with white metal working in cast iron guide faces fitted with water jackets. The astern guide faces were of bronze. There were eight main bearings in each engine. Balance weights were fitted to the crank shafts and at high speeds there was remarkable freedom from vibration. The air pumps were driven di-

rect off the forward ends of the crank shafts. Brass was used for the condenser shells and they were arranged so that the cooling water was forced through the tubes by the movement of the boat through the water. Auxiliary circulating centrifugal pumps were fitted for use in port. Four Normand type water-tube boilers were used. These were contained in two water-tight compartments with two firerooms. The uptakes of the forward and aft boilers led into the similarly situated funnels, and the two center boilers discharged into the middle funnel, which accounts for its large area as shown in the engraving in our Supplement. Forced draft on the closed stokehold system was fitted, fans in the stoke hold taking air through the above deck cowls and discharging into the room. Very complete automatic feed apparatus was fitted with Weirs' feed heaters and pumps. She also contained an evaporating plant capable of handling over 3,000 gallons a day, and there was also a distilling condenser which could supply 560 gallons a day of aerated fresh water for the use of the crew. There were many other auxiliaries, including independent air pumps and bilge pumps and ejectors, and steam steering gear was fitted.

The armament included two 14-pounder rapid-fire guns, one mounted on top of the conning tower forward and the other on a platform aft, also two 6-pounder rapid-fire guns and two 1.45-in. automatic guns, one on either side forward. There were also two 14-in. Schwartzkopff torpedo tubes mounted centrally on the upper deck so as to give discharge on either side.

Accommodation for the officers and men was quite elaborate. There were teak upper decks, in addition to the complete steel deck, and there was a very full electrical equipment for lighting and ventilation.

On trial with a load of 75 tons the Furor easily came up to the contract speed of 28 knots with 6,000 indicated horse power, and proved herself a handy, speedy boat. Her complement was 67.

The Pluton measured 225 ft. long; 22 ft. 6 in. beam; and 5 ft. 9 in. draught, and displaced 400 tons. She was fitted with triple-expansion engines built at Clydebank and Normand water-tube boilers. Her coal capacity was 100 tons. Her armament was the same as that of the Furor. On trial, with a load of 73 tons on board, she showed a mean speed of 30.12 knots on the measured mile, and during a continuous run of one and one half hour's duration a rate of speed of 30.02 knots; on a two hours' trial, with natural draft, the rate was 22.7 knots.

Properly handled, the destructive capacity of these vessels was enormous. With their automatic guns alone they could send out a frightful storm of small shells, and the large guns, which could be fired with great rapidity, possessed armor-piercing power.

The sixteen destroyers recently provided for by Congress are to be of this type.

TRANSATLANTIC LINERS SECURED BY THE GOVERNMENT FOR TRANSPORTS.

It is not often that an entire fleet of transatlantic liners changes ownership as suddenly as did the vessels of the Atlantic Transport line last month. They were purchased by the United States Government for use as transports under the control of the War Department, additional to the many fine coast liners previously secured by the Government and used for transporting troops to Cuba. Negotiations for the purchase of the ships were opened by the Government and the sale closed almost before these were generally known. The fleet purchased includes seven modern vessels which have been in the London trade. Of these ships five are sister ships, named Mobile, Mohawk, Massachusetts, Manitoba, Minnewaska, and the others are the Mississippi and Michigan. They were all built by Harland & Wolff, at Belfast, Ireland, and are comparatively new vessels.

The first named five are about 5,600 tons gross. They are fitted with twin screws and triple-expansion engines. Their dimensions are: Length, 445 ft.; beam, 49 ft.; depth, molded, 30 ft. The engines have cylinders 22 1-2 in., 36 1-2 in. and 60 in. by 48 in. stroke.

Both the Mississippi and the Michigan were also built by Harland & Wolff. They are single screw vessels of about 3,600 gross tons. Their dimensions are: Length, 370 ft.; beam, 44 ft.; depth, 26 1-2 ft. The engines are triple-expansion, have cylinders 25 1-2 in., 42 in. and 70 in. by 51 in. stroke.

The service maintained by the Atlantic Transport Line with this fleet included passengers, cargo and live stock. An extensive trade was also done with dressed beef carried in refrigerating chambers. The passenger accommodation on each ship was limited in extent and there was only one class-cabin—each vessel having accommodation for less than 100 passengers. Their general appearance is well illustrated in the view of the steamer Manitoba here printed.

Another fine ocean vessel secured by the War Department is the American liner Berlin, which, as the Inman liner City of Berlin, was the crack ship of the Western ocean in her day. She is an iron vessel 448 ft. 6 in. long between perpendiculars, 44 ft. beam, and 34 ft. 9 in. deep. She was built by Caird, of Greenock, Scotland, in 1874, and, as is shown in the engraving, she is of handsome model with the old clipper bow. Her original machinery was long ago replaced by a modern equipment, which includes triple-expansion engines with cylinders 41 in., 65 in. and 101 in. dia. by 66 in. stroke. Steam is generated in eight single-ended boilers 13 ft. 2 1-2 in. dia. and 11 ft. 4 1-2 in. long, at a pressure of 150 lbs. She is equipped with Ellis and Eaves induced draft. The Berlin is fitted with a single screw 21 ft. 6 in. dia. and 31 ft. 6 in. pitch. She has a continuous sea speed of about 15 1-2 knots, and for short runs

Netherlands-American S. S. Obdam *Atlantic Transport Line S. S. Manitoba.* *American Line S. S. Berlin.*

TYPES OF TRANSATLANTIC LINERS SECURED BY THE U. S. GOVERNMENT FOR USE AS TRANSPORTS.

has exceeded 16 knots. As a transport she will have accommodation for 2,000 troops, in addition to her own crew, and will have cabin accommodation for about 250 officers. She will also carry about 1,500 tons of coal and will have stowage space left for about 1,000 tons of freight.

Our other illustration shows the S. S. Obdam, of the Netherlands-American line, which was also secured for a troopship. She has been in the transatlantic trade between New York and Rotterdam. This vessel, which was formerly the S. S. British Queen, was built by Harland & Wolff, Belfast, Ireland, in 1880. She is a steel ship, 410 ft. long, 39 ft. beam and 28 ft. 9 in. deep, and is 3,700 gross tons. She was fitted with new machinery at Rotterdam last year, including triple-expansion engines with cylinders 28 3-4 in., 46 1-2 in. and 74 in. dia. and 51 in. stroke; also two double-ended Scotch boilers, each with six furnaces. Her sea speed is 15 knots.

To replace the ships sold to the Government, the Atlantic Transport line has purchased from the Wilsons-Furness Leyland line the fleet of steamers recently put into the London service. These ships are sisters of about 9,000 gross tons. They are the Alexandria, Boadicea, Cleopatra, Victoria and the Winnefreda. They are fitted up for a limited number of cabin passengers and large cargo carrying capacity. They were built at various British yards. Their general dimensions are: Length over all, 490 ft.; beam, 52 ft. 3 in.; depth, molded, 34 ft. 6 in. They have been built to conform to Lloyd's 100 A1 class. Each vessel has three complete decks and under the shade deck there is accommodation for about 700 head of cattle. Triple-expansion engines and Scotch boilers and very complete outfits of auxiliaries are installed in each ship. The passengers are accommodated in a large bridge-house on top of the upper deck and they have a promenade the full width of the ship. In the passenger spaces the decorations are extremely fine. The conveniences for passengers are in every respect up-to-date. The dining saloon, which is at the forward end of the bridge, is finished in mahogany and satinwood. The music-room is decorated in old English style, and the smoking-room is finished in teak, with walls covered with embossed leather.

Description of Vessels for Auxiliary Fleet.

In our list this month of auxiliary vessels secured by the Navy Department there are details given of about sixteen vessels, ranging from tugs to ocean frighters, which were added to the Navy since the publication of our previous lists. This makes a total up to date of between 130 and 140 vessels added to the Navy since the war preparations began. Referring to our third list, in the July issue, the old name of the tug J. D. Jones is there retained in the naval service. This has been changed to the "Apache," by which name the tug is now known.

WARSHIPS AND AUXILIARY VESSELS RECENTLY ACQUIRED BY THE UNITED STATES NAVY BY PURCHASE, CHARTER OR TRANSFER (*FOURTH TABLE*).

Old Name and Date.	Old Class.	Length.	Breadth.	Depth.	Draught.	Tonnage.	Horse Power.	Speed, Knots.	Where Built.	Hailing Port.	Former Owners.	New Class.	New Name.
Confidence, '80	Iron tug	85	17 6	9 5	.....	85 gross	.....	.....	Philadelphia, Pa.	Boston	.....	Tug	Waban
Elfrida, '89	Steel yacht	102	18	12 6	7 11½	123	215	10.6	Harlan & Hollingsworth	Shelbourne, Vt.	Dr. W. Seward Webb	Aux. Gunboat	Elfrida
Elizabeth Holland, '98	Steel freighter	254	39 3	$17 2	17 7¾	1,801	1,100	13	Sunderland, England	British	F. S. Holland	Collier	Leonidas
Hercules, '88	Iron tug	110	21	11	.....	141 gross	550	14	Camden, N. J.	New York	Standard Oil Co.	Tug	Chickasaw
Ice Boat No. 3, '73	Ice boat	195 9	33 3	.....	12	.....	.....	.....	.....	Philadelphia	City of Philadelphia	Coast Patrol	Arctic
Joseph Holland, '98	Steel freighter	254	39 3	$17 2	17 7¾	1,801	1,100	13	Sunderland, England	British	.....	Collier	Hannibal
Kanawha, '96	Wood yacht	146	17	10 6	7	127 gross	600	14	Seabury, Nyack	New York	John P. Duncan	Aux. Gunboat	Kanawha
Lighter No. 18	Wood tow barge	94 6	23 8	6 3	2 3	....	.....	.....	.....	Philadelphia	Phil. Trans. & Lt'ge Co.	.....	Trans. Lighter
No. 295, '98	Steel ya ht	153	20	10 6	8 6	159 gross	550	16	Roach's Yard, Chester	.....	{ Del. River Iron Ship Bldg. & Engine Works	Aux. Gunboat	Sylph
Norse King, '90	Freight steamer	340	41 1	26 3	23 7	2,985 gross	440 N.	.....	Sunderland, England	London	W. Ross & Co.	Distilling Ship	Rainbow
Oil Barge No. 55	Tow barge	120	30	10	.....	2,872 gross	400 N.	10	Newcastle-on-Tyne, Eng.	New York	Standard Oil Co.	Water Barge	WaterBgeNo 1
*Pedro, '83	Iron freighter	330 2	38 3	27 8	.....	4,154 gross	459 N.	8	Sunderland, England	Bilbao	Cia de Nav. La Flecha	Collier	Hector
Port Chalmers, '91	Steel meat str.	371	46 1	27 7	.....	3,256	3,000	14.5	Denny, Dumbarton, Scot.	London	Federal S. N. Co.	Supply Ship	†Glacier
Ravenna, '82	Freight pass. s.r.	393	40	28	17	136 gross	.....	13	Stephens, Glasgow	.....	.....	Collier	Scipio
Sylvia, '82	Iron yacht	139	18 6	9 4	8 6	1,966	250 N.	.....	Sunderland, England	New York	Ed. M. Brown	Aux. Gunboat	Sylvia
†Titania, '79	Iron freighter	232 6	35	24 2	.....	.....	.....	.....	.....	Hamburg	A. Kirsten	Collier	Marcellus

* Captured by Blockading Fleet in Cuban waters. The Pedro was formerly the S. S. Lilburn Tower.
‡ Former names S. S. C. Fellinger and S. S. Mercedes. § Hold.

† Temporarily named the "Delmonico."

Armed Yacht vs. Torpedo-Boat Destroyers.

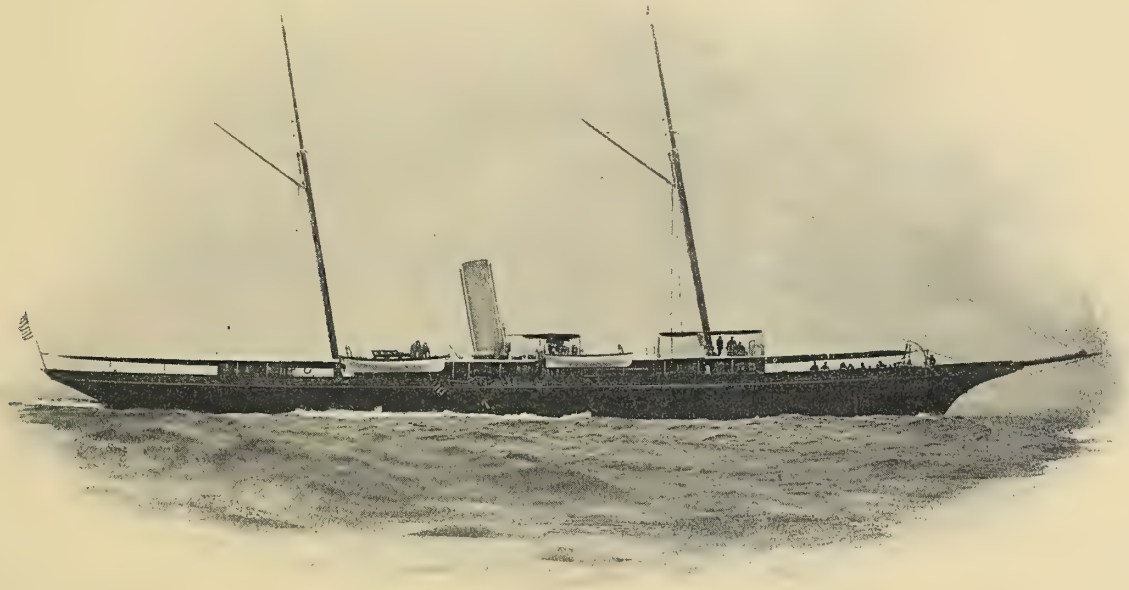
As remarkable a departure from the accepted in naval tactics during the Santiago fight (a battle full of surprises) was the attack made by the converted yacht Gloucester upon the Spanish torpedo-boat destroyers Pluton and Furor. During the fight, while the larger vessels of our squadron were busy pounding the Spanish cruisers, and giving but little attention to the destroyers, Lieutenant-Commander Richard Wainwright, of the Gloucester, started for the destroyers. In the earlier stages of the fight they naturally distanced her, but later, when the boats stopped their attempt to run away the Gloucester closed with them again and used her battery of 6-pounders with terrific effect. Though the boats were armed with guns as heavy as 14-pounders, their fire was not effective and they went ashore mere wrecks. The Gloucester's commander was one of the executive officers of the ill-fated "Maine" when she was destroyed in Havana harbor.

So interesting was the performance of the auxiliary gunboat Gloucester that we here present an exterior view showing her as she appeared as the S. Y. Corsair. She was one of the best known American steam yachts before her purchase by the navy. Her owner, J. Pierpont Morgan, is commodore of the New York Yacht Club, and consequently his yacht was flagship of the club squadron.

The "Corsair," now "Gloucester," is entirely a home product. Her designs were drawn by J. Beavor-Webb, of New York, and she was built at Philadelphia in 1890-'91. She is a very graceful vessel, a good sea boat, and has been entirely satisfactory as a luxurious pleasure yacht, and later as a gunboat of the U. S. Navy. Her dimensions are: Length, 241 ft. 6 in. over all; 204 ft. on water line; beam, 27 ft. 2 in.; depth, 16 ft. 5 in., and draught, 13 ft. She is a single-screw vessel and has triple-expansion engines with cylinders 21 in., 33 in., and 54 in. dia. and 30 in. stroke, of 1,900 indicated horse power. She is fitted with two Scotch boilers which carry a pressure of 175 lbs. per sq. in. Her gross tonnage is 560 tons. Her sea speed is 18 knots.

Trial Trip of the Cruiser Kasagi.

An official trial of the Japanese cruiser Kasagi was run over a course off New England in July. This vessel, which was built at Cramp's yard for the Japanese Navy, is one of the protected class of cruisers designed to have high speed. On trial with natural draft a rate of 20.6 knots was recorded, and with forced draft the average for a twenty-mile run was 22.76 knots, a fraction in excess of the contract speed, which was 22.5 knots. The trial was in every respect successful, and, we understand, the vessel has been taken over by the Japanese Government. Her dimensions are: Length, 374 ft. 6 in.; breadth, 48 ft. 9 in.; depth, 30 ft. 6 in., and trial draught, 7 ft. 9 in. Her displacement is 4,900 tons. She is fitted with twin screws and triple-expansion engines, giving a total of 17,000 indicated horsepower. Her armament, which will be fitted at the Armstrong works in England, will include two 8-in. breech-loading rifles, ten 4.7-in. rapid-fire guns; also twelve 12-pounders and six 2.5-in. Hotchkiss guns. She is also fitted with torpedo tubes for Whitehead torpedoes.



AUXILIARY GUNBOAT GLOUCESTER AS SHE APPEARED WHEN S. Y. CORSAIR.

HIGH PRESSURE AT SEA WITH SOME CONSIDERATION OF TYPES OF BOILERS.—IV.

BY W. R. CUMMINS.

Taking the usual proportions of heating surface in an ordinary return-tube boiler, and debiting each part with its own deficiency, the decrease of efficiency amounts to 9.5 per cent on the total surface. That is to say, assuming a steam economy of 18 per cent for 250 lbs. pressure, the boilers, if the ordinary return-tube type, could have 18 per cent less grate, but only 8.5 per cent less heating surface than the lower pressure boilers. As regards the combustion chamber, the return-tube boiler is very well off. The furnace crown, however, especially with small furnaces, is apt to cool down the gases given off by green fuel, but the fire-brick bridge acts as an equalizer of temperature and tends to counteract the cooling effect.

In order to institute a means of comparison between different types of boilers in the matter of combustion chambers, take, say, two single-ended boilers 14 ft. 6 in. by 10 ft. 6 in., with a heating surface of 3,750 ft., and a grate surface of 118 ft. We may take one-half the volume of the furnaces above the bars as forming part of the combustion chamber. This, together with the fireboxes, gives a total capacity of 480 cubic feet for the two boilers. Nothing better in the way of dividing up the gases into small streams, and ensuring their distribution over the heating surface could be desired than the arrangement of fire tubes of the present boiler. The distance traveled by the gases from the firebars to the uptake also allows ample time for the heating surfaces to absorb the desired amount of heat. In the boilers we have here taken as an example the mean distance traveled by the gases from the firebars to the uptake is 17 ft.

As regards the quantity of water over the highest heating surface, the boiler under question is perhaps superior to any other. Take the same two boilers as above indicating, say, 1,000 indicated horse power, the weight of water, 6 in. over the highest heating surface, would be 8,788 lb. Then, if the engine were using 16 lb. water per indicated horse power per hour, the feed could be shut off for 30 minutes without exposing the heating surface.

The return-tube boiler is fairly accessible for cleaning. All parts are fairly get-atable, except, perhaps, the firebox backs when the combustion chambers are deep. It is, however, a matter of great difficulty to renew any of the internals except the tubes. The furnaces are occasionally made that new ones may be substituted without disturbing the remainder of the structure, but if the firebox backs, or back tube plates require renewing, it is cheaper in the end to build a new boiler entirely. The return-tube boiler has a large space at the bottom, where grease and mud may collect without doing any harm. The water circulation, however, is very inferior on account of the large body of water under the line of the fire-bars, and the want of anything corresponding to the downcomers of the water-tube boilers. When raising steam from cold water some means of mechanically circulating the water in the boiler is essential, otherwise it may easily happen that the body of water under the line of fire-bars remains quite cold even when steam is being generated above, thus causing serious racking stresses in the boiler. Finally, as regards the cost of the return-tube boiler, it will certainly not cost less than a boiler working at 150 lbs. pressure and doing the same work, as, owing to the increased thickness of the heating surface and the increased temperature of the water, the higher pressure boiler will need to have almost as much surface as the lower pressure one, consequently its size cannot be reduced to any extent. This, added to the extra scantlings required for the higher pressure, will undoubtedly bring up the cost to that of the lower pressure boiler.

The other types of boiler which have been used on board ship are the locomotive type and the navy type. These have, however, been discarded for various reasons, hence the author passes on to the water-tube types. These can be divided roughly into two classes: those whose tubes are more nearly vertical than horizontal, and those whose tubes are more nearly horizontal than vertical. To the former class belong the haystack boiler, Yarrow's, Thornycroft's, Normand's, Fleming & Ferguson's, Reed's, Blechynden's and others; and to the latter class belong Bellville's, Babcock & Wilcox's, Niclausse's, Anderson & Lyall's, and others. The haystack boiler is totally unsuited for 250 lbs. pressure, although it is lighter and occupies less space than any of the shell boilers.

For the purpose of comparison we may take as one class the Yarrow, Thornycroft, Normand, Reed, and Blechynden boilers. As regards thickness of heating surface, these boilers are very favorably situated, as almost the whole of the surface, including that surface which takes up the radient heat of the fuel, is composed of tubes of small diameter, and, being exposed to internal pressure, may consequently be made very thin. The combustion chambers of these boilers are almost ideal, viz., a large free space over the fire-bars. To compare the volume of the combustion chambers of these boilers with that of the Scotch boiler, take, for example, three of any of the above types, having the same grate surface as two Scotch boilers, viz., 118 sq. ft. The volume of the combustion chambers for the three boilers will be about 525 cu. ft., which is more than that of the two Scotch boilers. Hence, this class of water-tube boiler, as regards combustion, should be superior to the Scotch boilers, provided the same quantity of coal were burnt per sq. ft. of grate, as the volume of the combustion chamber should be determined by the weight of coal burnt.

REPORT OF THE "MAINE" NAVAL COURT OF INQUIRY.

(*Third installment*).

Lieutenant-Commander Richard Wainright, in continuation was asked:

Q. Do you consider that the way she swung at the time she blew up was an unusual way for her to swing?

A. I never remember her swinging in that direction—remaining in that direction—for any length of time. She probably swung past that direction several times, but not to remain in that direction for any length of time.

Lieutenant John W. Blandin, watch and division officer of U. S. S. Maine, when called as a witness, testified:

Q. Do you know of any special orders that were issued by the commanding officer while in Havana in order to guard the ship more securely than at any other place?

A. The quarter watch was on watch all night. Small-arm ammunition was placed in the belts of the marines and of the quarter watch in the gun divisions, one hundred rounds. The boxes of 1-pounder and 6-pounder ammunition were stored in the cabin pantry (which is not used for anything else), the armory, and the pilot house. Sentries were posted on the forecastle and on the poop, with cartridges in their belts, but with orders not to load their pieces unless ordered by an officer. Orders were given to see that strict watch was kept, which was done. I think those were the principal precautions taken.

Q. During the time you stood watch in the harbor of Havana, did you ever know of any hostile demonstration afloat, in the way of boats approaching the ship that had to be warned off?

A. None whatever.

Q. How was the ship swinging at the time of that explosion?

A. She was riding to the ebb current.

Q. The ship is now lying pointing almost toward the admirality house or Machina. I suppose that is the way she was when she exploded?

A. I don't remember her heading, but the *Alfonso* was on our starboard quarter, the little gunboat was almost astern, and the *City of Washington* was on our port quarter.

Q. Would you be able to tell the court whether she was riding in an unusual direction for that harbor?

A. It didn't strike me so from the general appearance. I took no notice of her heading. She swung around the buoy for three weeks, about. She had probably been on every heading.

Q. Did she seem to be pretty steady on that heading that night?

A. Yes, sir.

Q. She was heading steadily in that direction?

A. She seemed to be. I had no cause to suspect any change.

Q. You know that ships swing a great deal in the harbor of Havana. Could you not tell us whether, from the time you took the deck until the time of the explosion, the *Maine* seemed to be heading almost steadily in one direction?

A. So far as I know, she was, from the bearings of other ships.

Q. How soon after the explosion do you think the forward part of the ship was under water?

A. The forward part, almost within a minute. I should estimate that, at the most, two minutes after the explosion the quarter deck was knee deep in water. She was on bottom in, I think, less than three minutes, all over.

Lieutenant George P. Blow, who was officer of the day on February 15, was next called, and graphically described the scenes following the explosion:

Q. Will you state to the court what you experienced during that explosion? We wish to know what you felt, what you heard, or what you saw.

A. I was writing at the time, and heard forward, and apparently at some distance—that is to say, well up in the bow, as far as I could judge from the sound—an explosion.

Instantly the lights went out. I rushed out of my room to see the cause of it, and before I could get more than probably 6 feet from my room a second and much more violent explosion followed. This explosion I would describe as being a continuous explosion, lasting for some seconds, and accompanied by the falling of lights, electric fittings, furniture, and by a crashing and rending of metal, and immediately by a sharp heel of the ship to port; the sound of rushing water from forward, and the cries and screams of men from about amidships. My first impression was that we had been fired on, and I remember feeling surprised that it should have been by such a heavy gun. When the second explosion occurred, followed by the listing of the ship, I recognied the fact that the ship was sinking, and had been blown up.

My impulse had been at first to go to my quarters, but at the second explosion I abandoned all thought of this, and realized that it was a question of whether I could reach the deck or not before the ship sank. A sharp heel of the ship, as I rushed forward feeling my way along the starboard bulkhead, caused me to lose my way amidst the wreckage, and for probably a moment I was confused as to my position. I soon found the bulkhead again, and, feeling my way along, reached a small china jar on top of the starboard steam heater, and recognizing this by feeling, found the starboard door leading forward. This door was closed and jammed. It could not be opened. I then felt my way across the deck to the port door. The list of the ship, which had probably closed the starboard door, had kept the port door open, and I had no difficulty in finding it. Stepping through the door, I reached the ladder, and ran into some one in the dark.

Q. What ladder was that? The one just outside the bulkhead?

A. Yes, sir; just outside the bulkhead, leading up to the wardroom proper.

Q. It leads into the cabin passage?

A. Yes, sir. We both fell, owing to the inclination of the deck, but, helping each other up again, we immediately crawled up the ladder, which was then nearly vertical. I am under the impression that this ladder fell immediately afterwards, as I heard a crash behind us. The water was then rushing in on the berth deck, though it was not quite up to the ladder, as she was heeled to port. Reaching the main deck, I felt my way through the starboard door in the after superstructure out on deck, and was surprised to find that everything was pitch dark, as dark as it had been below.

Q. That starboard door opens right out on the starboard deck?

A. It opens right out on the starboard deck; yes, sir.

Q. After passing through that you found it dark?

A. I found it perfectly dark there. I was surprised at the time to find it so dark. This was probably due to the fact that the quarter-deck awning had been dragged down by the fall of the third cutter. As I passed through the door I ran against some one hanging from the poop deck rail, who asked me to give him a push up on deck. This I did, and believing that there must be some good cause for his having taken that way of reaching safety, I quickly followed. At this time the main deck was still above water.

On reaching the poop deck I glanced forward and found the whole forward part of the ship a mass of confused wreckage, and apparently submerged up to and above the main deck. There were about a dozen men only to be seen on the poop deck. Among these I recognized the captain and the executive officer, Lieutenant-Commander Wainwright, who were giving orders to get out the boats for the purpose of saving the lives of the men in the water.

On the starboard side the beam and forward there were cries for help. Realizing at a glance that my boat, the third cutter, and that all the boats, in fact, forward, were gone, I turned aft to help to get out the only boats remaining. I found the gig manned and about to be lowered. I lowered the forward fall, and was surprised to find that the boat only went down about 6 or 8 feet. Thinking the stopper might have passed, or the blocks jammed, I asked the man in the bow if everything was all right. He replied yes. I asked him why the boat would not go down. He informed me that the boat was afloat. By that time the water had nearly reached the top of the superstructure deck. I then went forward again, and noticed that the wreckage had broken into flames, and I heard some one, I think the executive officer, say to the captain: "There is the wreck of the fire ship which they have sent down on us," pointing to the wreckage forward, which was now illuminated from the burning cellulose.

I then went to the port side to assist in lowering the barge. I found that she had already been lowered and was afloat. Before that, however, I would like to insert something. I am a little too fast. Before going forward again one of the midshipmen—I think it was Mr. Cluverius—came and asked me if he could be of any service. I told him to jump in the gig and take charge and save what life he could on the starboard side, which I believe he did. After this I went to the port side to assist in lowering the barge and I found that she was already in the water and afloat. There were already, I think, four men in her, however, to man her. So I went back again and called several who were standing on the poop and put them in the boat, and afterwards got in myself. I took charge of the boat, ordering the man at the helm to steer around on the starboard side, where most of the cries for help had been heard. After shoving off I found Lieutenant Jungen was in the boat, and he being my senior I turned the boat over to him and requested that he put me back. He said it was impossible, which was perfectly right. He pulled completely around the ship, and only succeeded in picking up one man on the starboard side, as we became involved in the wreckage and débris which was floating from a beam around the bow. The barge being very long, and only half manned, was very difficult to maneuver. We were continually backing and pulling out.

In that way we did not get around as quickly as we might have done. By this time the wreckage was all in flames, and I called Mr. Jungen's attention to the fact that I thought I saw men on the forecastle, as I supposed it to be, and asked him to pull in there and see if he could not get them off. We headed in for the wreckage, but ran into other wreckage, which we found out there to be the submerged portion of the forecastle and forward superstructure. We backed out and again pulled in toward the flames. We then found that it was the after part of the middle superstructure, abreast of the port crane. There were several boats there, which had already taken off all the men, so we pulled around on the port quarter, and again reported to the captain that the boat was there ready to take off anybody else. In the meanwhile the captain had ordered the ship to be abandoned. Mr. Wainwright asked us if we were all right. We told him yes, and asked the captain if he would not get in the barge. He replied, "No; I want my own boat," and then ordered all of our boats to go on board of the Ward Line steamer the *City of Washington*. He then put his orderly and every one else into the gig and got into the gig himself. We obeyed orders and went aboard the *City of Washington*.

Lieutenant Carl W. Jungen, watch and division officer, in the course of his examination, was asked:

Q. When did the lights go out in reference to this second explosion?

A. About simultaneously.

Q. Then you think the dynamo may have been destroyed at the second explosion?

A. Yes, sir.

Q. And not by the first?

A. Not by the first.

Naval Cadet D. F. Boyd, Jr., had a remarkably narrow escape, which he narrated to the court:

Q. Please state what you saw, heard, and felt.

A. I was sitting in the steerage reading at the time. The lights went out. A crashing booming was heard. I was struck in the back of the head with a splinter, and remember no more of the explosion.

A. When I collected my wits I grasped Assistant Engineer Merritt by the hand and told him to go up on deck. I pulled him out in the passage in the after torpedo room. We groped along the bulkhead until we came to the turn going over to the port side. At this moment the ship sank down amidships and heeled over on the port side. The rush of water swept us apart. I grasped the steam pipe overhead—the small steam-heater pipe—and worked my way down toward the steerage ladder, but it was gone. I worked my way over to the port side—on this steam-heater pipe—hoping to escape through some hole on the port side. The water was rushing through the air ports, so that I was not able to hang onto this small pipe. I grasped the torpedoes that were triced up under the deck beam, and, twining both arms and legs around it, I worked my way inboard toward the hatch, feeling the deck most of the time to find the hatch. The water at this time was almost over my head; almost up to the deck. Some burning cellulose flared up on deck, and I saw the hatch and made for it. I escaped through a mass of débris, on the hatch part of which was the second cutter.

Q. Again referring to the shocks, what kind of a shock did you first feel?

A. As well as I can describe, the shock was more that of a large freight train being coupled up together.

Q. That was the first shock?

A. That was the first shock.

Q. The other was continuous, so far as you can remember, you say?

A. Yes, sir.

Gunner Joseph Hill, who had served in the "Maine" for twenty-one months, was questioned in his examination about the electric light fittings:

Q. Were magazines and shell rooms always carefully locked after they had been opened?

A. Yes, sir.

Q. And the keys turned in?

A. Yes, sir.

Q. There was always a regular care taken in the delivery of the keys and the locking of the shell room and magazines?

A. Yes, sir.

Q. Are the magazines lined with wood?

A. No, sir; not as I remember. The plates are bare, of course, and the only woodwork I remember there is the stowage racks, holding powder, tanks, and shells. They are made fast to the metal bulkhead.

Q. Is there any electric wiring that leads into the magazine that would be dangerous?

A. No, sir; the wires seemed to be well insulated. Of course they led into the light box, but, as I remember, they came down through the deck, and then went at an angle into the light box itself. As I remember it, the wires went through a metal casing.

Q. You considered the wiring perfectly secure?

A. Yes, sir; of course it may have been woodwork painted over white, but I never examined it very closely. It looked very much to me as if it was metal.

Q. You never had any trouble with the light boxes in the way of grounding—with the lights in the light boxes?

A. Yes, sir; the dynamo tenders found considerable trouble in keeping the magazine lights in order. They always gave as an excuse that the system was grounded down around the boxes.

Q. But the wiring laid directly from the upper deck into the boxes, in two metal cases?

A. Yes, sir; but as I remember it, I think it went down through the deck in some places, and then went at an angle into the light box itself.

Passed Assistant Engineer Frederick C. Bowers, of the "Maine," was examined at length. During his testimony he was asked:

Q. Please state to the court what precautions have been taken on board the *Maine* during her commission against spontaneous combustion of coal?

A. The order has been to inspect the bunkers every day, and log it. In the case of every bunker that had an escape door, we have always opened those doors to examine the bunkers; and generally the coal that has been in the ship the longest has been used the first, as near as possible.

Q. As far as you know, these orders have been carried out, have they?

A. Whenever I was on duty they were.

Q. When were you on duty last on board the *Maine?*

A. The 14th day of February.

Q. The day before the explosion?

A. Yes, sir.

Q. You came off that morning at what time?

A. At 8 o'clock.

Q. Can you give the history of bunker A16, which is the port bunker forward abreast of the 6-inch reserve magazine? Give the history of the coal inside.

A. That bunker was stored in either Newport News, Va., or at Norfolk. It contained soft coal; Pocahontas, I think. If it came from Norfolk, I inspected it. It was full of soft coal, about 40 tons.

Q. Were not the bunkers immediately abaft of it, B4 and B6, empty?

A. Yes, sir.

Q. The after bulkhead of A16 was easily accessible?

A. Yes, sir.

Q. What other sides were accessible to ascertain the temperature in case it should have been over hot?

A. You could feel it from the wing passage, and there was an escape door on platform deck A. There was a sign there, "Keep that door closed." That was on account of the opening into the passing room, the loading room.

Q. What was the condition of the after boilers—the two that were used for auxiliary purposes?

A. The fires were practically banked on the six furnaces of the two boilers. In what respect do you mean?

Q. The condition of the boilers.

A. The boilers were in good condition—in very good condition.

Q. You do not consider there was any danger of their having too much pressure on for safety when you were working them for auxiliary purposes on the evening of the explosion?

A. No, sir; the safety valves blow at about 130 pounds, and we usually carried 80 to 100 for auxiliary purposes.

Q. Where were you at the time of the explosion?

A. I was ashore.

Q. Did you have the usual thermostats in the bunkers?

A. Yes, sir; but they didn't work very well. Sometimes they rang when there was no coal in the bunker.

Q. I believe you never had a fire from spontaneous combustion in that ship, did you?

A. No, sir. We thought we did once, but it was a leaky steam-pipe—a leaky exhaust pipe from the ice machine.

Assistant Engineer John R. Morris, of the "Maine," was also called and questioned:

Q. You were on duty the day of the explosion?

A. Yes, sir.

Q. When did you inspect the bunkers on that day?

A. It was some time during the forenoon; I think between 10 and 11 o'clock.

Q. Can you remember distinctly making a careful inspection of bunker A16, the port forward bunker?

A. I remember of opening the escape doors, and there was no heat perceptible, more than just the temperature of the hydraulic room, which is next to the bunker.

Fireman William Gartzell, of the "Maine," testified that he was at the tiller room adjoining the storeroom and over a magazine when the explosion occurred. He described his experiences in a straightforward, interesting way:

Q. Tell the court exactly what you felt, and heard, and saw.

A. Just a second before that Rushford, chief machinist, came to me and asked me for the loan of the keys to go in the storeroom. He said he was restless and couldn't sleep. I gave him the keys and told him to put the keys near my shoes, that I was going to sleep there that night. I laid there. I had a book in my hand and was going to read. Gardiner was lying down beside of me. Just as soon as I laid down, I was talking to him and I hadn't spoke three words. He was telling me his time was out in May, and I said mine was out in June, and he made the remark that he was going to wait for me—all like that, just fooling, and just then a flash came. It was a blue flash. It seemed to me like it was right by the lamp in the engine room. I could see as plain as day.

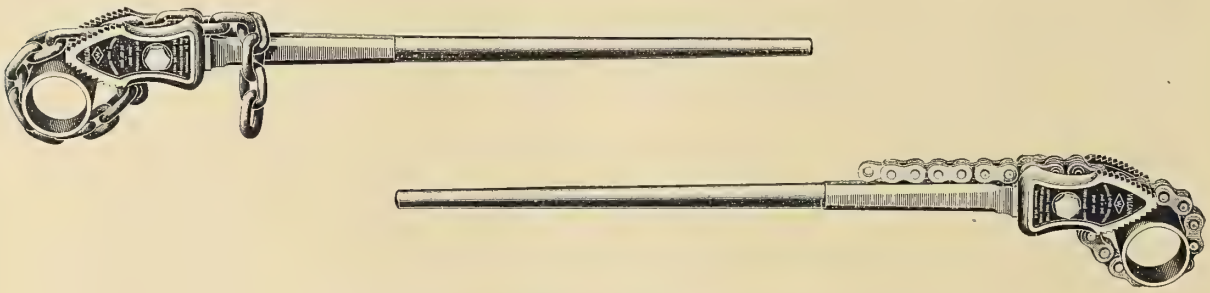
Q. How could you see into the engine room?

A. I could see through the door, sir. It was a kind of a blue flame, and it came all at once. The two of us jumped up, and I went on the port side up the engine-room ladder, and Frank Gardiner, he went up the starboard side—at least he didn't go up, because he hollered to me. He struck the door right there where the partition separates the two doors, and he must have struck his head. He hollored to me; he says: "O Jesus, Billy, I am gone." I didn't stop then, because the water was then up to my knees. I made a break as quick as I could up the ladder, and when I got up the ladder into the steerage room the ladder was gone. Everything was dark. I couldn't see nothing; everything was pitch dark, and I gave up, or I started to give up. There was a colored fellow with me; I didn't know his name until afterwards. His name was Harris. We got hold of each other. I says: "Let's give up; there is no hope." I started in to say a prayer the best I knew how, and I heard a voice. It must have been an officer; it couldn't have been a man's voice, because he says: "There is hope, men." I knew from that that he was an officer. After that I seen a little light. It looked like an awful distance from me, but I made for that light, and when I got there it seemed like I could see the heavens. It got jammed in the ladder. My head was right up against the deck. I seen the ladder, and I caught hold of Harris, and the two of us hugged each other.

IMPROVED APPARATUS.

Vulcan Drop Forged Chain Pipe Wrench.

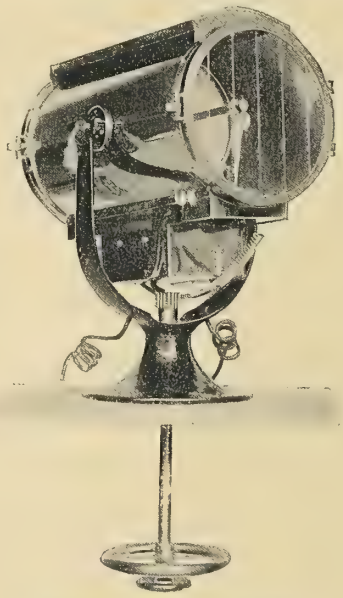
For gripping, turning, or holding pipe, bolts, bars, and shafts, from 1-8 in. to 12 in. dia., the Vulcan drop-forged chain pipe wrench is an exceedingly convenient tool. Either cable chain or flat link chain can be used with one wrench, the change being readily effected. The flat link chain is usually preferred for use in handling pipe, while the cable chain is used quite extensively when handling fittings. The drop-forged jaws are of saw temper, so that when dulled the teeth can be sharpened with a file. In working with this form of wrench the danger of crushing is obviated, as the pressure of the teeth is on a line tangent to the circumference of the pipe, and the encircling grip of chain distributes the power applied very evenly. It will be noticed that the chain swings from the center, and can be used on either side of the jaws, prolonging the life of the wrench as originally purchased. It is made on the interchangeable system, so that any portion can be purchased separately, and the wrench always kept in good condition. This tool is manufactured by J. H. Williams & Co., 31 Richards street, Brooklyn, N. Y.



VULCAN CHAIN PIPE WRENCHES WITH FLAT AND LINK CHAINS.

Carlisle & Finch 9-in Projector.

To meet the demand for a small, compact and moderate priced searchlight projector, the Carlisle & Finch Co. is now making a 9 inch lamp, as shown here, which embodies all the good points of the larger lamps. This lamp is made in Form "1" and "3" only. It consumes from 5 to 8 amperes of current, according to the resistance in circuit. It throws a very powerful light for so small a lamp, and it is possible to pick up buoys at 1-3 to 1-2 mile distance with it. All parts of the case and trimmings are well made and neatly finished. The case or cylinder is made of brass, highly polished, and the stand of iron or brass, as ordered. The illustration shows the Form "3" lamp. Form "1" is the same in every particular, except the pilot house steering gear is omitted. These lamps are fitted with silvered copper reflectors or with high grade glass lens mirrors, according to the wishes of the purchaser. The copper reflector used is a shallow parabola and throws a very good light. If desired the wires from lamp may be brought down and out through the base of the lamp. In this case they will come inside of pilot house alongside the steering tube. No sliding contacts are placed in the base of the 9 inch lamp, as there is not enough room to permit their use. The feeding of the carbons is produced by a magnetic trembler that is very accurate and positive. Lamps of this type are in extensive use on yachts and launches, and on Yukon River boats. The manufacturer's address is Cincinnati, Ohio.

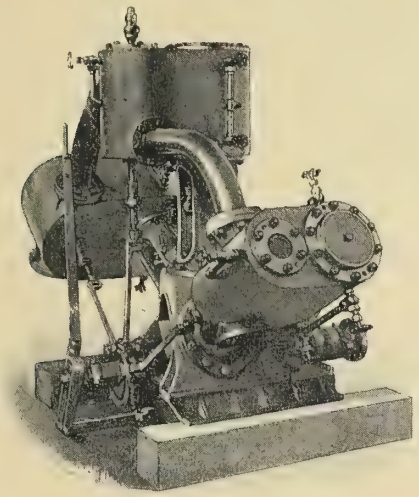


CARLISLE & FINCH PROJECTOR.

Yankee Twist Drill Grinder.

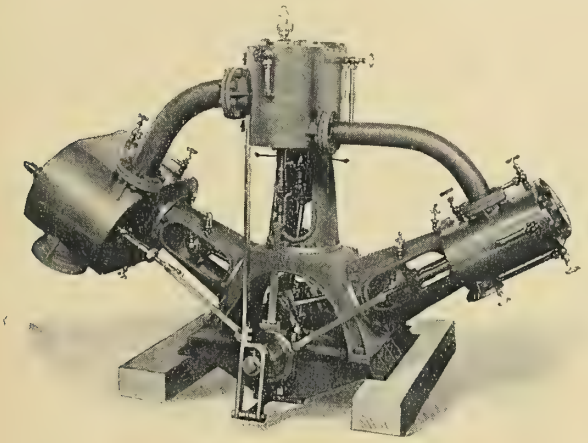
A compact workshop appliance is here shown in the cut of the Yankee Twist Drill Grinder, which contains many points of excellence. The machine illustrated occupies only 1 1-2 ft. by 3 ft. floor space and is 4 ft. high, and weighs 225 lbs. It will accurately grind any size of drill from 1-8 in. up to 2 1-4 in. dia. and can also be used for grinding flat drills and chucking ream-

ers. The drills are laid in V blocks, which are moved laterally only during the grinding process, so that the drills are centered true and both lips



WARD TRIPLE-EXPANSION ENGINE.

ground geometrically alike. Any desired clearance can be given, the drill being ground by a slight thumb screw adjustment. In construction the machine is well adapted for the work. The bearings on the grinding wheel spindle are

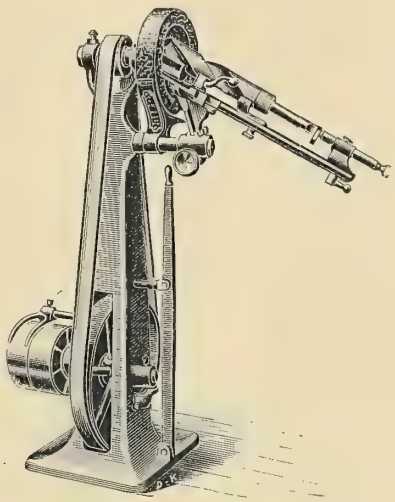


WARD TRIPLE-EXPANSION ENGINE.

long, the pulley surfaces are large, and there is protection at the oil holes to exclude grindings from the bearings. The machine is manufactured by the G. T. Eames Co., Kalamazoo, Mich.

Ward Triple-Expansion Marine Engine.

We here present two views of a novel triple-expansion marine engine, having only one crank and one eccentric, which was designed and built by the Ward Engineering Wks. of Charleston, W. Va., the manufacturers of the Ward water tube marine boilers. It will be seen that, instead of arranging the cylinders as usual, in a line above a three-throw crank shaft, they are placed radially with the shaft and connected to a single crank. The intermediate cylinder is placed vertically and midway between the high and low pressure cylinders, which are at an angle of 60 degrees on either side. This arrangement disposes the power on the single crank at three equal points of the circle, producing the same result as the ordinary triple, having three cranks arranged at 120 degrees with each other. The valve gear is exceedingly simple, consisting of a single eccentric, which is moved from the go-ahead position to astern, by travel across the shaft, produced by a sliding wedge moving in an angular channel in the body of the eccentric. The valve rod of the center cylinder is secured fast to the eccentric strap, while those of the two outside cylinders are pivoted. It is obvious



YANKEE TWIST DRILL GRINDER.

the three cylinders being radial with the shaft that the eccentric controls the valves of all three cylinders alike and in proper sequence; so when the eccentric is moved across the shaft by the hand lever the engine is linked up, reversed, or thrown on the center at the pleasure of the operator. The engine is fitted with piston valves throughout, and also with thrust bearings. While the cylinders show considerable spread athwartship the length occupied is about one-third that of an engine of like power, having three cranks and the usual link motion: thus saving an equivalent length of ship or boat and a large amount of mechanism, viz., two main cranks, two main bearings, five eccentrics, three link motions. Gains are thus effected in weight, first cost, friction and maintenance, while the running qualities are improved and the vibration reduced to the minimum. The engine illustrated has cylinders 7 in, 10 1-2 in. and 16 in. dia. and 10 in. stroke, and is designed for 200 lbs. steam pressure and 500 revolutions.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.

S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representatives.

L. L. CLINE, Detroit, Mich., 47 Hodges Building.
B. M. GARDNER, Chicago, Ill., 1522 Monadnock Block.

Traveling Representatives.

E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

LET the text books on naval operations be burned. Manila and now Santiago have shown, simply, that in the destructive as in the constructive arts America can depart from the orthodox and be easily successful. Prior to these demonstrations of our naval efficiency had any student or authority, in matters naval, declared that five cruisers and three gunboats could be turned into scrap without the loss of a man (as at Manilla), or that four magnificent cruisers and two up-to-date destroyers could be shattered, and sunk, with only the loss of one man killed and two wounded, as a list of casualties at Santiago shows, he now would be the inmate of a padded cell. The higher his attainments the sadder would be the expression of his friends who might exclaim: "Poor fellow, how sad to see such a brilliant mind give way." The American Civil War evolved the ironclad, and gave the torpedo a standing in tactics, thus changing the complexion of the fleets of every navy. The Spanish-American war has already pointed new ways, not so much in construction, perhaps, as in operation. It is not ended yet, and, at its close, there will probably be also a change in constructive policy in naval circles, as a result of the Santiago fight. What problems in construction need further solution cannot yet be clearly stated, for the reason that accurate technical details of the damage caused by our fire are so far not obtainable. Some of the enemy's vessels are submerged and those still above water have not been exhaustively reported upon. On our ships, little could be learned regarding details of construction or equipment to be avoided or changed, for they were not put to any severe test by the Spanish fire. There was opportunity, of course, to decide, by practical experience in action what additions might be made in the various apparatus in the machinery or batteries, to render our ships more effective offensively. A fact which the details already made known clearly emphasizes however, is that the modern warship is a floating machine ship. There is not only the extensive installation of main engines and boilers, with their numerous auxiliaries, needing attention, but the equally important machinery used in manipulating the guns and in getting the ammunition to the guns. It was all round efficiency rather than any brilliant feats of leadership which gained the glorious victory at Santiago. This is what gives comic-opera flavor to the dispute—started no one knows how—as to whether Commodore Schley or Rear-Admiral Sampson is entitled to the credit. From the moment the Spanish vessels were sighted coming out of the harbor, until the Colon helplessly touched bottom, it was a fight of ships and components of ships rather than a fleet action. The words of Wellington: "Up Guards and at 'em," best describe the occasion. When the warning signal was given general quarters found every man in place. Our vessels were at a disadvantage in that full steam was not, of course, on the boilers. But no words of encouragement to the crew down below were needed when the captains rang for full-speed ahead. The engineer forces could have given pointers to trial trip experts. Fires were stirred and coal heaved into the furnaces by the ton, draft fans started, and in the engine rooms, throttles opened and the links put into full gear ahead; then, watching feed, lubrication, and the condensers, the engineering staffs could only trust in fate that no shell would burst a steam pipe, and so turn engine room and stokehold into a rendering tank in a slaughter-house. Above decks the only navigation needed was to keep each ship on her course, and other than this to load and fire as fast as ammunition could be brought up, and as often as the gun sights bore on the enemy's ships. To the Captain of each ship belongs the credit of having kept up to the highest notch of efficiency his vessel and crew.

THE loss of the S.S. La Bourgogne is additional evidence that in a collision the vessel striking end on has a far better chance of surviving than the vessel which is struck broadside. There are notable exceptions to this, the most recent which occurs to us being the collision between the U. S. cruiser Columbia and the freight steamer Foscolia, off Fire Island, in May. It is not infrequent for vessels to reach port with bows crushed in and forward compartments full. The ramming of an iceberg by the Guion liner Arizona (now a U. S. transport on the Pacific coast) will be recollected as a severe test. A remarkable case of midship damage which did not result in the loss of the vessel was the accident to the Inman liner City of Paris (now the Yale of our Navy). The smashup of her starboard engine carried away the sea connections and flooded both engine compartments. Experience has proven that there is no form of construction that is absolutely safe under all conditions of disaster; and theoretically such a design would be impossible, involving physical contradictions. It has been shown, however, that even in extreme cases the safety of the vessel is assured by modern methods of construction; and in nearly all, with prompt and intelligent handling, the sinking of a vessel may be so delayed that those on board can get away in safety. No inanimate apparatus, however, can replace the workings of human intelligence and bravery in time of great peril, and this brings us back to the La Bourgogne disaster. According to the more trustworthy reports of survivors panic took hold of those in authority, and, naturally, the demoralization of subordinates and passengers followed. Brute strength and self-preservation were rampant. In discipline could lie the only salvation for all on board, and when the officers resigned the management of the ship in favor of ignorant and cowardly firemen and so-called sailors, the fate of those on board was settled. On English-speaking liners it is customary for the captain to retain command of his vessel in emergencies, and he has the co-operation of a set of officers who are prepared to obey. Duty and a heavy navy revolver enforce all commands, and an instant's violent disobedience means death from other causes than drowning. "Women and children first" has ever been the watchword on these transatlantic liners. When the smashup on the Paris occurred the Chief Engineer and members of his staff went into the engine room, in black darkness, amid a horrible tangle of broken machinery, with the ship rolling each way over 20 degrees, in an effort to close the sea connections. Not until the inrushing water had reached up to their heads did they retreat, and then only to labor with desperate energy shoring up the adjoining bulkheads. With 3,000 tons of water inside, the ship was thus kept afloat and reached port in safety. In such lines the traveling public may well have confidence, for, better than all bulkheads and water-tight doors, there are men in command.

A CHARACTERISTIC feature of the work of our vessels in the recent naval operations is the dare-devil spirit so often displayed. At the commencement, we have the entrance of Admiral Dewey's squadron into Manila harbor in spite of all torpedoes reported and actual. Then Naval Constructor Hobson takes the collier Merrimac under the fire of the coast guns at Santiago in as deliberate a fashion as though going ashore in a friendly harbor. Next a transatlantic liner, the St. Louis, tackles a thirty-knot destroyer, the Terror, at San Juan and sends her back to shelter disabled and impotent for evil. And in the battle at Santiago Lieutenant Commander Wainwright crowds on all steam on a pleasure yacht, armed only with 6-pounders, and gives battle to two thirty-knot destroyers, with crushing effect. In addition to these remarkable episodes there are, almost, daily reports of heroic deeds, the moral effect of which will be felt for generations.

SOME time ago, in the course of an editorial about defects in British built vessels, we referred to a cable message from Valparaiso, which was very widely published in this country. The message stated that a torpedo-boat destroyer built in England for the Chilian Government was found to be so defective in construction as to be absolutely worthless. We have received a communication from a representative of Messrs. Laird Bros., of Birkenhead-on-the-Mersey, in which that firm makes this statement:

"We have built the only torpedo-boat destroyers that Chili has got, and every one of the reports that we have received, even up to to-day, go to show what complete satisfaction they have given since they left our works."

Our informant adds that the Laird Bros. have completed and passed through their trials considerably more than a dozen 30-knot destroyers.

MISHAPS AT SEA.

LOSS OF THE FRENCH LINER LA BOURGOGNE WITH 550 LIVES.

One of the most fatal and probably the most horrible mishaps in the passenger trade on the Western ocean occurred July 4, when the French liner La Bourgogne was ran into and sunk by the British sailing ship Cromartyshire and more than 550 passengers and crew of the liner were drowned. The collision occurred in a dense fog about 60 miles south of Sable Island. Between the time the blow was delivered and the liner disappeared below the water only a few brief minutes elapsed, but during this time there occurred scenes of cowardice and crime which could only find parallel among the most depraved of savage tribes. To this entire absence of discipline or co-operation among those on board the awful loss of life was apparently largely due. The vessel had nearly 800 persons on board, of whom about 165 were saved and of these only one was a woman.

Shortly before 5 o'clock on the morning of July 4 Captain Oscar Henderson of the Cromartyshire while in his chart room heard a steamer's whistle. His ship was moving at about four knots speed with the fog horn sounding. He was unable to locate the direction of the siren, and an instant or so later his ship rammed the La Bourgogne on the starboard side about amidships. The adjacent compartments of the liner filled immediately, changing her trim so that the decks were at a steep angle to starboard. The blow had smashed some of her boats on the starboard side, and the inclination of the ship made the handling of boats on the port side a difficult matter, even if any organized effort had been made to launch them. From the testimony of passengers who were saved a horrible scene of confusion followed the collision on the liner. Most of the passengers were in their berths at the time and they rushed out, wildly excited, as persons who were awakened from a sound sleep, in unfamiliar surroundings, to meet probable death might be supposed to become. Passengers who were saved say that among those who reached the boat deck—principally sailors and steerage passengers bound for Austrian and Italian points—desperate fights occurred for places in the few boats which were launched. Knives were freely used, and the time wasted in these cowardly combats accounts for the failure to get afloat some of the rafts carried, or to make emergency preparations for saving life. In her condition of instability the ship was a difficult place to even walk on, and the inrush of water speedily destroyed her buoyancy and she sank. Some of the boats which had been gotten out were swamped, and many passengers afloat were carried down in the final plunge and suffocated. Many who were afloat, clinging to wreckage, tried to get into the boats and rafts which had been safely launched or on the floating wreckage, but they were, in many instances, beaten back and drowned. Among all these brutish scenes the conduct of some ministers of religion was conspicuously noble. They went among the terrified passengers, saying words of comfort as long as the ship remained afloat, and thus, neglecting their own safety, they perished.

Some of the cabin passengers succeeded in getting into boats, but there was apparently no effort made to get these boats into the water, and the occupants were carried down with the vessel. One of the boats so filled is said to have been smashed to pieces by one of the funnels which fell on top of it.

Meanwhile the Cromartyshire had drifted away with her forward compartment full, but her bulkheads were staunch and some of the cargo was jettisoned so as to improve her trim. About half an hour after the collision a boat filled with sailors from the liner came alongside and told Captain Henderson of the disaster. The boats of the sailing ship were immediately put out and her crew rescued many of those from the liner who had kept themselves afloat.

Not a single officer of the La Bourgogne was saved, and for this reason, and because of the secrecy imposed by the French line on the members of the crew saved, no clear technical account of the mishap could be had. The members of the crew were brought to New York and sent home on another of the French liners. Three boats got away from the liner and reached the Cromartyshire safely. The first boat contained sailors in a majority, if not exclusively, and the other two also contained many of the crew of the liner. In all, out of the 160 odd persons saved, only about fifty were passengers and the remainder members of the liner's crew.

About three hours after the collision the Allan liner S. S. Grecian was sighted and took the Cromartyshire in tow, reaching Halifax, N. S., July 6.

In the engraving which we here print the S. S. La Bourgogne is shown as she formerly appeared with four masts. At the time of the mishap she had only two masts and no yards, for the main and mizzen masts had been removed when the vessel was overhauled last year. New machinery was then fitted in her and many additional conveniences for ocean travelers supplied. She was built at the Forges et Chantiers, La Seyne, France, of steel, in 1886. Her general dimensions were: Length over all, 494.5 ft.; load water line, 480 ft.; beam, 52.3 ft.; depth from main deck, 34.4 ft.; tonnage, net 2,985; gross, 7,395; displacement, 9,925 tons at 24 ft. draught. She was fitted with ten bulkheads in accordance with Bureau Veritas rules and United States regulations for a vessel of this class. She had accommodations for 1,236 passengers and crew. About 600 could be carried in the steerage and 400 in the first and second cabins. The crew, officers and men, numbered about 220. There were twelve large boats and four life rafts on the ship.

When built she was fitted with compound engines driving a single four-bladed screw 21 ft. dia. Last year when she was altered new engines and boilers built at St. Nazaire were fitted. The new engines were triple-expansion with cylinders 42 in., 44 1-8 in. and 79 in. dia. and 67 1-2 in. stroke. There were twelve single-ended Scotch boilers 9 1-2 ft. long by 15 1-4 ft. dia., each fitted with three 36 in. furnaces. The working pressure was 160 lbs. She had a sea speed of about 18 knots.

The Compagnie Generale Transatlantique, owner of the La Bourgogne, has been singularly unfortunate in respect to marine mishaps and disasters. Serious accidents to machinery, causing delays and anxiety, have been frequent, and disasters attended with loss of life not uncommon. In March, 1897, the S. S. Ville St. Nazaire, belonging to the company and trading between New York and the West Indies, foundered in a severe storm off the Virginia coast. In attempting to lower boats many lives were lost, as the heavy seas dashed the boats to pieces against the ship's side. In one boat thirty-five persons got away safely, but of those only seven were alive—mostly insane—when the boat was picked up at sea seven days later by the schooner Hilda, of Perth Amboy. Another boat load was rescued by an ocean steamer on its way to Europe.

Another awful disaster in the history of the company was the loss of the liner Ville du Havre, which was sunk in collision with the sailing ship Loch Earn in latitude 47 N., longitude 35 W., on November 22, 1873. There were 313 persons on the liner, and of these only 87 were saved, including 33 first-class passengers, 10 of whom were ladies, 29 firemen and boys, and 25 of the crew, including the captain and five of his officers. The night was clear and

both vessels had proper lights burning, and there was a heavy sea with but little wind. The sailing ship struck the steamer amidships and tore an enormous hole in her side. In less than fifteen minutes the Ville du Havre filled and went down head first. After the collision, according to the testimony of survivors, there was an entire absence of concerted effort to save anyone. Sailors and coal passers made a desperate rush for the boats. The long boat was launched, only to be smashed by the main mast, which fell and killed most of those in the boat, including a number of steerage passengers. Only a whaleboat and the captain's gig were launched before the vessel went down. Boats were lowered from the Loch Earn and many in the water were rescued. Among those who were lost were Judge Rufus W. Peckham, of Albany, N. Y., and his wife. Some of the survivors recalled having seen him standing beside his wife on deck, encouraging those around him and saying, "If we must go down let us do so bravely." In this way, with as much exterior calmness as though delivering a verdict on the bench, he waited for death. The Loch Earn was badly damaged by the collision but kept afloat. She spoke the American ship Trimountain next day, and on account of her leaky condition transferred her passengers to the American ship. The Loch Earn was a Glasgow vessel of about 1,200 tons.

The Ville du Havre was, for her time, a fine vessel. She was built of iron at the Thames Iron Works in 1866 as a side-wheel steamer, and early in the seventies she was thoroughly overhauled. The hull was lengthened and she was fitted with compound engines and a single screw. Her dimensions were: Length, 423 ft. 6 in.; beam, 43 ft., and depth, 33 ft. 7 in. Her gross tonnage was 5,000 tons. She was valued at $1,500,000 and carried a cargo worth $300,000. M. Surmont, the commodore of the line, was in command of her when she was lost.

FRENCH LINE S.S. LA BOURGOGNE AS SHE APPEARED IN HER ORIGINAL RIG.

Burning of Clyde Liner Delaware.

Fire destroyed the Clyde line steamship Delaware while on a trip from New York to Charleston on the night of July 8. During the afternoon she left her pier in the North River with a full cargo and 32 passengers, of whom nine were women and three children. About 9.20 o'clock at night one of the crew reported that there was a fire in the after hold. Captain A. D. Ingram and his officers and crew began a thoroughly organized effort to save the ship and provide for the safety of the passengers. The fire pumps were, of course, started and several streams of water directed into the hold. Meanwhile the officers, assisted by Stewardess Ellen C. Hill, notified the passengers to be prepared to take to the boats. Some of the passengers were inclined to be hysterical, but the self-possession of the officers calmed them and the preparations went on uninterruptedly.

As the vessel was built of wood, the fire found

ample material to feed on besides the cargo, and Captain Ingram, seeing that there was no chance to save his ship, headed her toward the shore, the Delaware being then in the vicinity of Barnegat, on the Jersey coast. Fortunately the sea was calm, and when the fire had reached the upper deck the order was given to lower the boats. Women and children first, then passengers, crew and officers, and finally the Captain, in an orderly manner, got into the boats and on the life rafts, and kept together in the vicinity of the vessel, that now served as a signal for assistance. A life boat from the shore reached the Delaware shortly after. The passengers were finally taken back to New York on a tug which was bound out with a tow when the blazing vessel was sighted.

Few of the crew were without severe burns received in fighting the fire, and many brave acts occurred before the vessel was abandoned. Chief Engineer Clayton Platt, when the fire had reached the machinery spaces, groped his way to the boiler room and released the safety valves to prevent the possibility of an explosion. Both engineers and firemen remained at work until the smoke became so dense that they were in danger of suffocation.

The Delaware was a wooden steamer, built at Hillman's yard in Philadelphia nearly twenty years ago. She was 250 ft. long, 37 ft. beam, and 17 ft. 8 in. deep. Her gross tonnage was 1,646 tons. The cargo consisted chiefly of provisions, dry goods and saltpetre, and with the ship was worth about $230,000.

CORRESPONDENCE.

Concerning Specifications for U. S. Destroyers.

The circular for destroyers and torpedo boats in your June number invites a criticism, and as similar clauses have occurred in previous circulars for boats of this class, I take this opportunity to call attention to them.

The requirement for bunker capacity and for coal carried on trial, both in the case of destroyers and boats, should be stated as coal to steam a given distance at a given speed and not as a fixed weight.

The reason for this is from the fact that, while two boats may be of exactly the same size, one of them may take 50 per cent. more coal than the other to go the same distance, owing to the wastefulness of her machinery.

The economical boat is manifestly much more advantageous to the Government, and some inducement ought to be offered to the builder to get economy of coal.

If the circular read, "total bunker capacity must be supplied for coal enough to enable the boat to steam 3,000 miles at 14 knots," and in the list of trial weights "enough coal in the bunkers at the beginning of the trial to steam 1,000 miles at 14 knots," this desired economy could be had. This coal could be determined from a previous trial at 14 knots on which the consumption of coal is accurately measured.

The above system would offer an inducement to the builder to furnish economical machinery, because he could see a way of reducing his load carried on the full speed trial, and hence he stands a better chance of getting his guaranteed speed. On the contrary, if his machinery proved wasteful, he would have to carry an extra load on trial.

A Subscriber.

In awarding contracts for the new battleships the Navy Department will give special consideration to speed and coal endurance. A circular to be issued will advise bidders of this, and will place the steaming radius of the battleships at 5,432 knots at 10 knots speed.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—XI.

BY WM. BAXTER, JR.

To give an idea of the appearance of machines in actual use, the construction of which was diagrammatically represented in Fig. 49, two machines are here

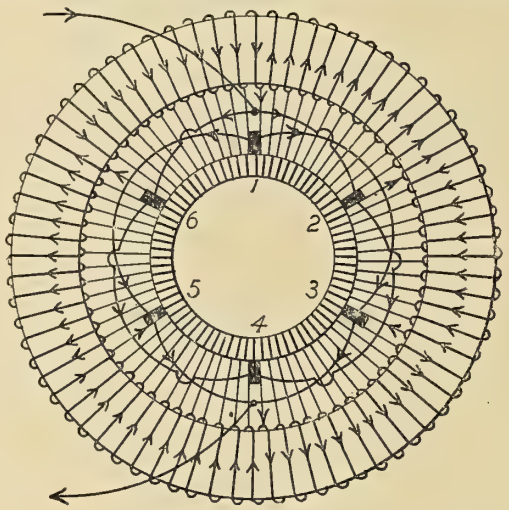


Fig. 57.

shown. Fig. 55 is arranged to be belt driven, a form that still finds favor on some ships, though it has been to a great extent displaced by the direct connected set. A direct-connected engine and four-pole generator representing the latter form is shown in Fig. 56.

The manner in which the armatures of multipolar machines are wound is substantially the same as in the two-pole type, but that which corresponds to the drum winding of the latter, appears to be very differ-

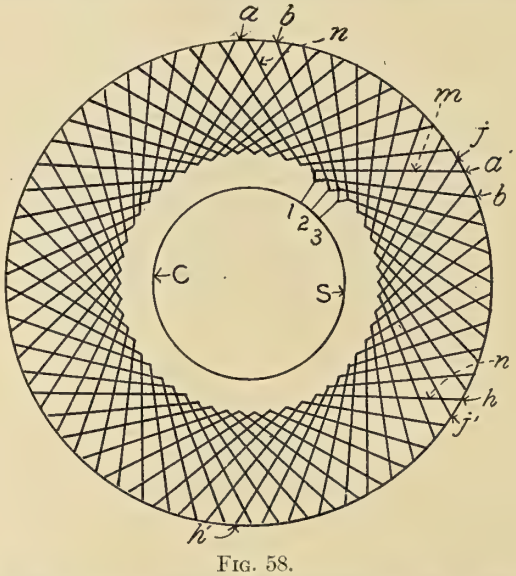


Fig. 58.

ent. The ring winding is identical, as can be seen from Fig. 57, but the manner in which the coils are connected with the commutator is not the same, except for what is known as the parallel con ection, which is the kind shown in this figure. The direction of the current through the various coils, as well as

through the wires leading to the brushes, is indicated by the arrow heads. It will be noticed that the current coming in at the top divides into two branches and passes to the brushes located at the upper corners, and from these proceeds to the lower centre brush. The current from these three brushes passes into the armature coils, and after going through one-

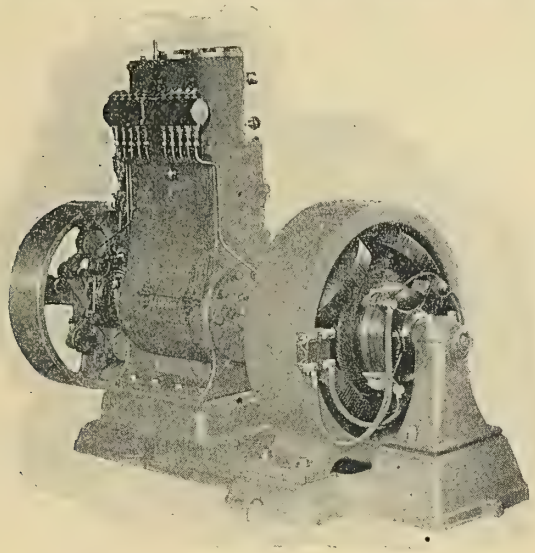


Fig. 56.

sixth of the number of coils on either side passes out to the intermediate brushes and thus to the lower wire. With the simple two-pole ring winding it will be remembered that the current divides on entering the armature from the commutator brush, one-half passing through each path, and unites again at the other brush, each current traversing one-half

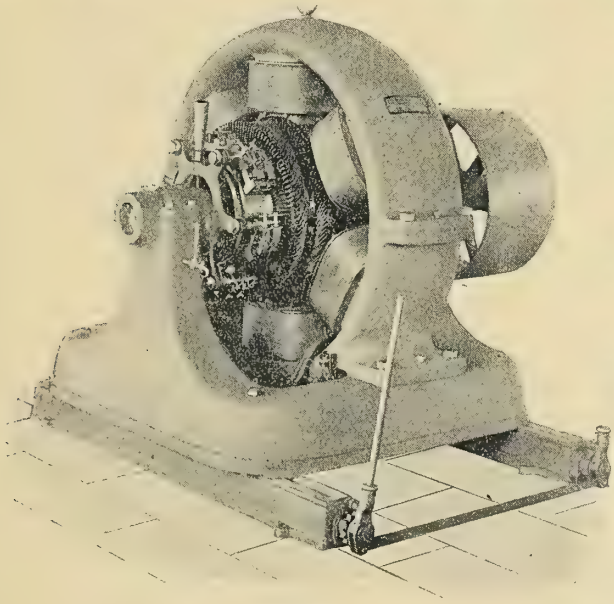


Fig. 55.

of the armature circumference. Considering this we see that if the armature rotates in a two-pole field and the commutator is provided with two brushes, each current will pass through coils covering one-half the circumference. From this we would at once infer that if the machine has four poles, and four commutator brushes, each current would only pass around one-quarter of the circumference before reaching the other brush, and this is strictly correct. If the machine has six poles each current will pass around one-sixth of the circumference, and for ten poles around one-tenth of the circumference, and so on in proportion. A little reflection on this point will show that an armature wound in the manner required for a two-pole ring winding will run equally well in a field of any number of poles providing as many brushes are placed upon the commutator as there are poles, and that the alternate ones are all connected with each other. Under these conditions the voltage between the adjoining brushes will be reduced directly in proportion to their number, that is, if there are four brushes the voltage will be half as great as if there are two, and with eight brushes one-fourth as great. At the same time, since the wire is not changed, and there are in the four-pole machine twice as many currents, and in the eight-pole machine four times as many, the strength of the current in one case will be twice as great, and in the other four times as great. If we desire to keep the voltage at the same point we can accomplish the result by so connecting the armature coils that the voltage of one section is added to that of the others. This is what is called series connection. To connect a ring wound armature in this manner it is necessary that the ends of the coils be connected, not with the adjoining one, but with the end of a coil occupying the same relative position in the next adjoining magnetic circuit. To illustrate, suppose we take the first coil to the right of the upper brush in Fig. 57, in the figure one of its ends connects with the coil to the left of it and the other end with the coil to the right. Now to connect the coils in series, one end of this coil would have to be connected with the opposite end of first coil ahead of brush 3 and the other end of this coil would be connected with the coil ahead of brush 5. The end of this last coil would be carried to the coil back of, or ahead of the coil from which we started. From this it will be seen that the difference between parallel and series winding is that in the latter the first coil to the right of brush 1 connects with the first coil to the right of brush 3 and thence with the first coil to the right of brush 5, thus making a complete circuit of the armature, and from this point the connection goes to the coil next to the one from which we started. The end of the second coil must then connect with the second coil ahead of brush 3, and the end of this with the second coil ahead of brush 5, before we can connect with the third coil ahead of brush 1. If a diagram is drawn in which all the front ends of the coils pass directly to the commutator segments, and the other ends are carried around and are connected with the segment to which corresponding coils are connected, the connection will be correct for a series winding. To make the connections symmetrical, however, it is necessary that the number of coils be such that it must be increased or decreased by one to be divisible without a remainder by half the number of poles. We will not go more fully into an explanation of this part of the subject, at the present time, as it will be treated at length in a future article.

The drum winding of multipolar armatures is called "formed" coil winding, or simply coil winding. It receives this name from the fact that the coils are not wound in place, as is the case with ring winding, or to pole drum winding, but are made on forms and are then assembled in their completed form upon the armature core. In two-pole drum winding, it will be remembered that the wire is carried across to the opposite side of the diameter, this being necessary so as not to have both sides of the coil opposite poles of the same polarity. In a multipolar machine, however, the adjoining poles are of opposite polarity, hence, it is only necessary to carry the coil as far around the circle as the next pole. Fig. 58 will serve

to give a general idea of the manner in which formed coils are placed upon an armature and their connection with the commutator. The figure represents a six-pole winding. The lines *a a'* which represent the two sides of one coil are one-sixth of the circumference apart, and, as will be seen, if we were to wind the wire in a straight line from one to the other it would come so near to the edge of the core that before many coils had been put on there would be no room left for the succeeding ones. In order to make room, therefore, it is necessary to run the wire down toward the center as indicated by the lines *n m*. Now if the part *n* of the coil *a* is placed close to the surface of the core, and the part *m* is, say, one-quarter of an inch further from the surface than the space occupied by *n*, then the part *n* of all the coils will pass freely under the part *m* and the coils will fit into each other without crowding at the ends. At both ends of the armature the coils are made of the same shape, so that the lines *n* and *m* can be regarded as covering similar lines at the pulley end, the part shown being the commutator end.

If a coil-wound armature is connected with the commutator in parallel it is said to have a lap winding, and if in series, a wave winding. Why these

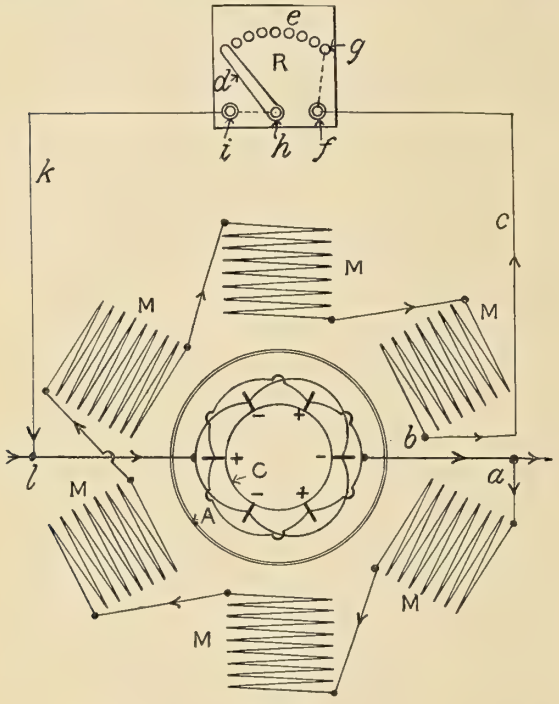


Fig. 59.

names are given will be understood from the following explanation of the connections: Let *a a'* and *b b'* be the two sides of adjoining coils, then if the connection is in parallel, the end of *a* coming from the *n* side will be joined to the end of *b* coming from the *m* side, the two ends being carried to the commutator segment marked 1. Then the end of the *b* coil coming from the *n* side will be connected with the end of *c* coil coming from the *m* side and these two ends will be carried to the commutator segment 2. By examining this method of connection it will be seen that coil *b* laps onto coil *a* and *c* onto coil *b*, and the same order will be maintained all the way around the armature, hence, the term lap winding. If the armature is to be connected in series, the end of coil *a* coming from the *m* side will not be connected with the adjoining coil, but will be carried to a commutator segment located at *s*, and to this same segment will be connected the end of coil *h* coming from the *n* side. The end of *h* coming from the *m* side will be carried to a commutator segment one-third of the circumference ahead of *s* and to this latter segment will be attached an *n* end of the coil whose *m* end will connect with commutator segment 2. From this it will be seen that the connection progresses forward all the time in a series, or wave, that is, the appearance of the coils and their connections upon the diagram is a wave line.

A ring-wound armature, if in parallel connection, can be used in a field of any number of poles and will be as accurately connected for one as for another, but with a parallel coil-wound armature this is not true, except in a limited sense. If the armature is wound and connected for six poles, it can be used for four or even two poles, but it will not do as much work in either of these fields because part of the wire will act against another part. In a two-pole field the capacity of the armature will be one-third of what it is in a six-pole field.

A parallel connected armature, whether the winding is ring or coil, must have as many brushes on the commutator as there are poles, unless the commutator is cross connected, which is seldom the case, but if the connection is in series, two brushes will be

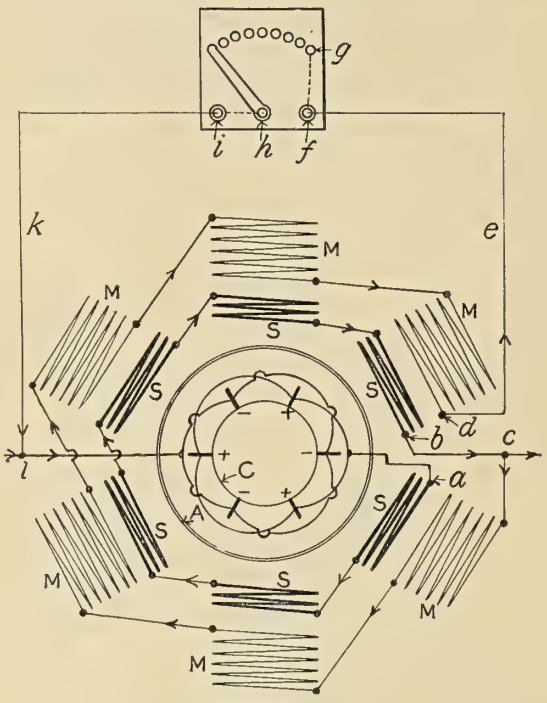


Fig. 60.

sufficient for any number of poles, although the number of brushes can be made anything from two up to the full number of poles.

The field coils of multipolar machines are wound in the same way as those of the two-pole type that is, in shunt, in series or compound. Very few multipolar machines with series-wound fields are used, in almost every case the winding is shunt or compound. Fig. 59 illustrates a shunt winding for a six-pole generator, and Fig. 60 a compound winding for a similar machine. As will be seen, in the shunt winding the current derived from the armature circuit at *a* passes through all the field coils in succession, and from the end *b*, goes by wire *c* to one of the binding posts of a regulating resistance *R*, commonly called a rheostat. In this rheostat, the post *f* is connected with the contact *g*, which is the last of the series of contacts *e*. The switch lever *d* connects with the wire *k* through *h* and *i*. The con-

tacts *e* are connected with each other by means of a considerable length of wire so that when the lever *d* is in the position shown, the current has to pass through several lengths of wire before reaching *k*; but if *d* is moved around toward *g* the number of these lengths will be reduced, all being cut out of the circuit when *d* rests upon *g*. When *d* is in the position shown the current passing through the field coils will be the smallest, because it not only has to force its way through the coils, but also through the resistance of the wire between the contacts *e*, and when it is moved over until it rests upon *g* the current is the strongest, for then it has only the resistance of the field coils to overcome. By placing *d* at intermediate points between the ends of the contacts *e*, different strengths of field current can be obtained.

In Fig. 60 the current for the shunt coils *M* is drawn from the armature circuit at *c*, but it can also be drawn from *a*. When drawn from *c* the arrangement is called a long shunt, and if from *a*, a short shunt. The full armature current passes through all the series coils *S* before reaching the point *c*. The regulating rheostat is placed in the shunt coil circuit. Both these windings it will be seen are the same as for the two-pole machines, and the regulating rheostat, which was not explained in connection with the latter type, is used in the same manner in both, its object being to change the strength of the shunt-coil current, and thus the strength of the field and the voltage of the machine.

ENGINEERS' DICTIONARY—VIII.

Boss or *Hub (of a propeller)*.—The central body of the propeller which supports the blades and communicates the motion to them from the shaft to which it is attached. The same term is often used more generally and more vaguely for any rounded-out portion of a structure through which a hole or a shaft is passed.

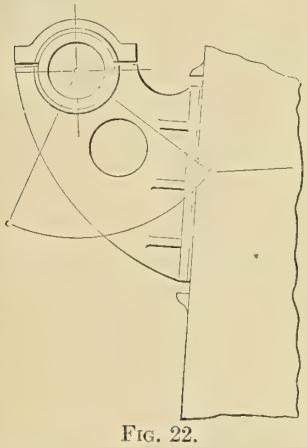


Fig. 22.

Bracket or *Bracket Bearing*.—A form of bearing supported by a projecting arm or bracket, as illustrated in Fig. 22, showing the support of a reversing or weigh shaft. The stern *shaft brackets*, for twin screws are arranged as illustrated in Fig. 23. These are also called *A frames* at times. The term *bracket* is also used signifying a brace in the angle of a casting.

Brine.—Sea water more or less concentrated as in a boiler by the evaporation of the water and accumulation of the salts. Ordinary sea water holds in solution about 1 part in 32 of solid matter consisting mostly of common salt. Water in boilers may become concentrated to a point where the solid matter reaches from 3 to 5 parts in 32. In engines with jet condensers the density of the water is a matter of constant observation.

Brine-cock.—See *Bottom-blow*. Used also in reference to a cock or valve used to draw water from the boiler for the purpose of testing by a *hydrometer* the amount of solid matter, or "*saturation*," as it is frequently termed. The more correct name for the latter is *salinometer cock or valve*.

Brine-pump.—A pump sometimes used to withdraw a part of the water in a boiler in order to prevent an excessive rise in the *saturation*.

Bronze.—A general term for alloys of *copper* and *tin*, or of *copper*, *tin* and *zinc* in varying proportions, and in some cases combined with other materials or subjected to special treatment giving special alloys

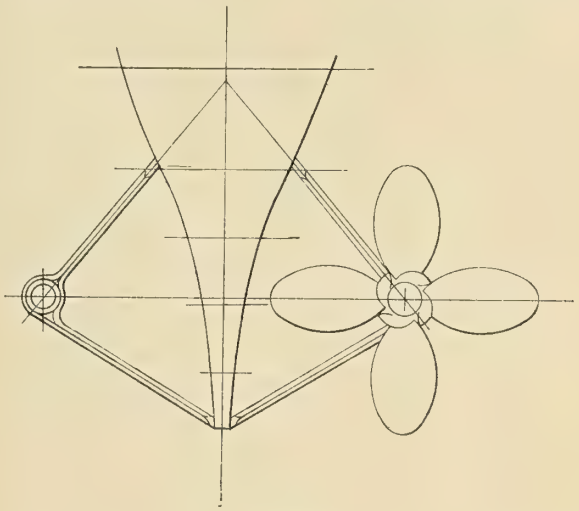


Fig. 23.

such as *manganese bronze*, *phosphor bronze*, *deoxidized bronze*, etc. The bronzes are in general harder, stronger and stiffer than brass. The strongest copper-tin or bell metal alloy is in the proportions of about 83 per cent. copper and 17 per cent. tin, its strength being about 33,000 lbs. per sq. in. of section. The strongest copper-tin-zinc alloy is in the proportions of 55 per cent. copper, 5 per cent. tin and 44.5 per cent. zinc, its strength reaching about 60,000 lbs. per sq. in. of section. For particular purposes, however, various other proportions of these constituents are used. The strength of the special bronzes approaches closely to that of cast steel, ranging, as it does, from 50,000 to 65,000 lbs. per sq. in. of section.

Bucket.—(1) Sometimes used in speaking of the *floats* of a paddle wheel. (2) Used in referring to a vertical pump piston fitted with valves opening upward. The latter are also known as *bucket valves*. See *air-pump*.

Bunker.—A compartment for the stowage of coal. From 42 to 44 cu. ft. are allowed per ton of 2,240 lbs.

Bush or Bushing.—A cylindrical lining used to reduce the size of a hole worn too large, or an accurately bored lining fitted to a hole for bearing purposes.

Butt-Joint of Seam.—A form of riveted joint in which the plates are placed with the edges together,

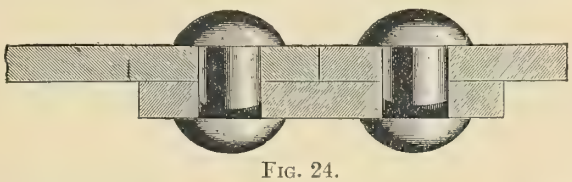


Fig. 24.

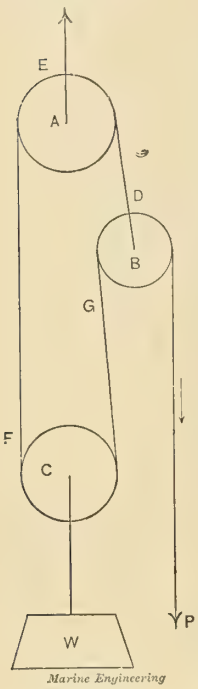
as in Fig. 24, and are joined by means of one or two *cover plates* or *butt straps*.

Butt-weld.—A form of weld for plates or bars in which the pieces are joined together with little or no *scarf*, and by pressure on the edges or ends.

By-pass.—A valve and passage allowing the flow of steam or water past or around, instead of through, an engine, pump, stop valve, or other mechanism. See also under *Bleeder*.

QUERIES AND ANSWERS.

Q.—What is the value of the purchase shown in the sketch; that is, if a man can pull 100 lbs., what can he lift with the purchase? We have had a big discussion over the question and can't agree, and an answer in your columns would be highly appreciated? FIFE-RAIL.



Marine Engineering

A.—The purchase in your sketch, and from which the figure has been drawn, is a well-known and ancient gag or catch, especially among officers of the navy. In appearance it somewhat resembles a Spanish burton, and without careful attention is apt to deceive anyone seeing it for the first time.

It is not a purchase at all, and no weight whatever can be lifted at W. If we suppose that a weight lying on the deck is attached by a rope to the block C, and that a strain is put on P, what will happen is this: The rope D E F G will render right around the blocks A and C just as though the rope were fast to B, while the latter will consequently move down to C, where it will jam, and the original relation of the rope and blocks becomes entirely changed. So long however, as the purchase remains in the condition shown in the figure, the rope will simply render around A and C and lift nothing, as a moment's examination of the diagram will show.

This arrangement of rope and blocks is frequently known as the "Jackass Purchase," and the fitting character of the name is not apt to be called in question except by those who have been taken in by it.

Q.—How do you proportion the size of a marine boiler to the size of the engine? WATERTENDER.

A.—Assuming that you refer to the usual type of Scotch boiler, and that with the size of the engine there will be known its general characteristics, including steam pressure and revolutions, and, in fact, all data necessary to the determination of the I. H. P., and to the formation of an intelligent opinion as to its economic performance. At least, this data must be in hand before an intelligent step can be made toward the design of the boiler. For the present purpose, then, all that is necessary to consider is that it is the business of the boiler to furnish steam of a given pressure to the engine, and the requirement to be met is therefore most naturally expressed in terms of the hourly consumption of steam of the given pressure. To design a properly proportioned boiler, which under the given or assumed conditions shall be able to provide the required amount of steam, reference must be had to actual experience with boilers of similar type working under similar conditions. The details of the process may be arranged in the following series of steps:

(1) Determine or assume the requirement in lbs. of steam per hour. This must be done having in view the probable economy of the engine which is to be supplied. For modern quadruple and triple expansion engines with steam pressures from 200 to 160 lbs., this figure will range from 12 or 13 to 16 or 17. In warship practice the number of expansions of the steam at full power is usually less than in mercantile practice, and the economy is consequently somewhat poorer. In consequence, somewhat higher figures for steam consumption must be taken in such cases. For compound condensing engines with steam pressures from 140 to 100 lbs., the figures usually range from 16 or 17 to 20; for simple condensing engines from 20 to 30, and for simple non-condensing from 30 to 40 and upward. An appropriate figure having been thus taken for the lbs. of steam per I.H.P. per hour, multiply this by the I.H.P. and the result will be the required total number of lbs. per hour.

(2) Having in view the quality of the coal and the nature of the draft, next assume the number of lbs. of steam which can be evaporated by one lb. of coal. With good coal and moderate or assisted draft this will usually be from 9 to 10. With hard forced draft the conditions will be less favorable to economy, and the figure may drop to from 7 to 9. Having made this estimate, divide the total number of lbs. of steam by the lbs. of steam per lb. of coal, and the quotient will be the lbs. of coal to be burned per hour.

(3) Again having in view the quality of the coal and nature of the draft, assume the number of lbs. of coal which can be burned per square foot of grate surface. With good coal, good firing and natural draft, this will usually be found from 12 to 18. With assisted and forced draft the amount will rise to 20 or 30 or more. Divide the total lbs. of coal per hour by this figure, and the quotient will be the necessary number of square feet of grate surface. This gives one of the most important characteristics of the boiler.

(4) Next assume the ratio between the heating surface and the grate surface. For Scotch boilers this is usually found between 25 and 35, the value being in general higher, as the draft is higher and combustion per square foot of grate surface larger. The grate surface multiplied by this ratio will then give the square feet of heating surface.

(5) As the next step the number of boilers and the number and disposition of the furnaces in each may be decided upon. Modern marine furnaces will provide somewhere about 20 sq. ft. of grate surface each, and with a little trial some combination of furnaces and boilers, either single-ended or double-ended, or both, may be made to suit the given circumstances. The dimensions of the grate and furnace can next be selected, and in this connection it should be remembered that the length of grate be made not greater than 6 ft., as a longer grate is difficult to fire and keep clean. The diameter of the furnace, and hence the width of grate, is usually found between 36 in. and 48 in., the higher the steam pressure, or the greater the number of furnaces in one boiler, the smaller the diameter.

(6) This point being reached, proceed with the further design of one of the units selected. Experience shows that somewhere about 85 per cent. of the heating surface of a Scotch boiler is furnished by the tubes, and the remainder by the furnaces and combustion chambers. Take, therefore, the total heating surface for one boiler, and multiplying by say .85, get the heating surface to be furnished by the tubes.

(7) The length of tube may be taken from 6 in. to 15 in. or 18 in. longer than the grate. Then choose a trial diameter, remembering that boiler tubes are always measured on the outside, and thus find the heating surface on one tube. Then divide this into the heating surface to be furnished by the tubes, as found in (6), and find thus the requisite number of tubes. This result must, however, be checked by a determination of the resulting calorimeter ratio.

(8) The calorimeter is the total cross-sectional area for the passage of the gases measured inside the tubes. To find the inside area of a tube, deduct twice the thickness from the diameter, and find the area of the corresponding circle. This area, multiplied by the number of tubes, will give the calorimeter area desired. The grate surface divided by this calorimeter should give a ratio of from 5 1–2 to 7 or 8, lower as the draft and rate of combustion are higher. If this quotient is too small, the length of the tubes must be increased or the diameter decreased, or both. If the quotient is too large, changes in the contrary direction must be made. After a few trials, a combination of dimensions and proportions will be found by which the various requirements will be fulfilled, and the result may be considered as a consistent disposition of characteristics, having in mind the especial circumstances of the case.

(9) The length of boiler may usually be taken for single-ended boilers from 36 in. to 42 in. longer than the tubes, and for double ended boilers perhaps 6 in. shorter than twice the length of a similar single-ended boiler.

(10) To determine the diameter of boiler, the drawing board must be resorted to, and by trial it must be found what diameter is necessary to accommodate, with the necessary clearance and usual proportion of steam room, the furnaces and tubes specified in the foregoing.

Thus the chief characteristics of the boiler have been found, and from this point on the design is principally a matter of structural detail. There are many different ways besides those here stated in which you may proceed from the given data to the desired characteristics. Thus you may pass directly from the I.H.P. to the coal per hour, or to the grate surface, or to the heating surface. The method outlined above, however, is probably the safest and most convenient for connecting the given conditions, and special circumstances as to coal, draft, etc., with the necessary characteristics of the boiler. These other relations may then be used as checks in order to make sure that the entire combination forms a mutually consistent whole. With triple expansion engines the coal per I.H.P. per hour is usually found from 1.5 to 2 lbs., the I.H.P. per sq. ft. of grate surface from 10 to 15, and the heating surface per I.H.P. from 2 to 3 or 3.5.

Example:

Required to design boilers for triple expansion engines intended to develop 6,000 I.H.P.

(1) Assume engine will require 15 lbs. steam per I.H.P. per hour. Then $6,000 \times 15 = 90,000$ lbs. *steam per hour.*

(2) Assume 1 lb. of coal will evaporate 8 lbs. of steam. Then $90,000 \div 8 = 11,250$ *lbs. of coal per hour.*

(3) Assume moderate forced draft giving a combustion of 22 lbs. of coal per sq. ft. of grate. Then $11,250 \div 22 = 511 =$ *grate surface.*

(4) Take heating surface $\div$ grate surface $= 33$. Then $511 \times 33 = 16,863 =$ *heating surface.*

(5) Take first each furnace as giving about 20 sq. ft. of grate. Then the number of furnaces would be $511 \div 20$, or 25 and a fraction. The number of furnaces must be exact and should be a multiple of 4 or 3 or both, so as to make possible a suitable subdivision of boilers. In this case, then, take 24 furnaces each of $511 \div 24$, or 21.3 sq. ft. area. This number of furnaces may then be combined in various ways. They could be variously disposed, thus: Eight 3-furnace single-ended boilers, or four 3-furnace double-ended, or six 4-furnace single ended, or three 3-furnace double-ended and two 3-furnace single-ended, or two 4-furnace double-ended and two 4-furnace single-ended, etc., etc. The grate surface in one furnace being 21.3, next take its dimensions as follows:

Width of grate.....3.5 ft., or 42 in.
Length of grate.....6 ft. 1 in.

A length of 6 ft. and area of 21 sq. ft. will be sufficiently near to the requirements.

(6) Now go on with the further design of one of the three-furnace single-ended boilers, as follows:

The grate surface will be 3 × 21.3, or 63.9.
The heating surface will be 16,863 ÷ 8 = 2,108.
85 per cent. of this is 1,792.
(7) Take for trial the tubes 3 in. diam. and 7 ft. long. Then heating surface of one tube is 5.5 sq. ft., and 1,792 ÷ 5.5 = 326 tubes.
(8) Take the thickness of tubes as No. 8, or .17 in.
Then, dia. of hole = 2.64 in, area = 5.47 sq. in., and total calorimeter = 5.47 × 326 ÷ 144 sq. ft. = 12.38.
Then, 63.9 ÷ 12.38 = 5.16.
This is small and indicates the use of longer or smaller tubes, or both. With tubes 2 3-4 dia. and 7 ft. 3 in. long, the result by the same process would be:

No. of tubes, 343.
Calorimeter area, 10.86.
Calorimeter ratio, 5.88.

Or, with tubes 2 1-2 in. dia. and 7 ft. 6 in. long, as follows:

No. of tubes, 365.
Calorimeter area, 9.28.
Calorimeter ratio, 6.89.

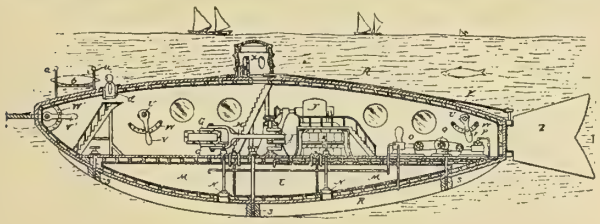
Either of the latter arrangements might be expected to give satisfactory results, and a choice between them would depend on secondary considerations beyond the scope of this discussion.
For check ratios these are important:

Coal per I H.P. per hour..... ..... = $\frac{11250}{6000}$ = 1.875
I H.P. per sq. ft. of G. S..... ..... = $\frac{6000}{511}$ = 12 app.
H. S. per I.H.P .... = $\frac{16863}{6000}$ = 2.81

SELECTED PATENTS.

604,185. SUBMARINE BOAT. *George W. Bennum, Georgetown, Del. Filed June 18, 1897.*

In a submarine boat, pockets formed in the sides thereof, shafts journaled vertically in the pockets and projecting to the interior of the boat, shanks on the shafts, fins pivoted to the shanks to swing vertically, a crank-shaft journaled in the boat, pitmen extending from the inner ends of the first-named shafts to the crank-shaft, and means for driving the crank-shaft. In combination with a submarine boat, a shaft journaled across the bow of the boat and extending to the exterior, at its ends, a blade secured to the ends of the shaft, a lever secured to the interior portion of the shaft, a segment having holes therethrough and a pin adapted to be passed through a hole in the lever into a hole in the segment. In a submarine boat, pockets formed in the sides thereof, shafts journaled vertically therein, shanks secured on the shafts, fin propeller-blades hinged to the shanks to swing vertically, stops on the shanks and lugs on the propellers



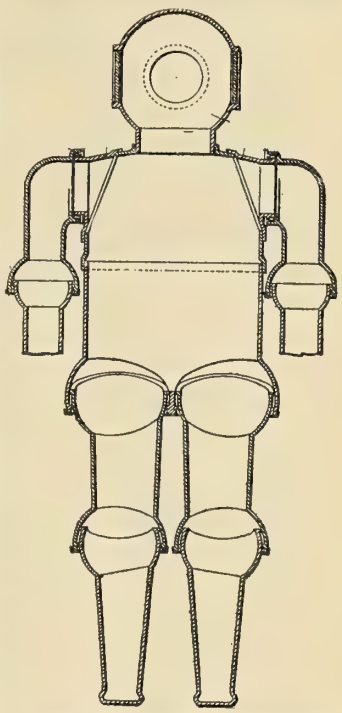
BENNUM SUBMARINE BOAT.

adapted to come in contact with the stops. Propelling mechanism consisting of vertical shafts, ratchet-wheels on the shafts, pawls to engage the ratchet-wheels, gear-teeth on the upper face of the ratchet-wheels, shanks on the shafts, propeller-blades journaled thereon, gear-teeth on the propeller-blades meshing with the first-mentioned gear-teeth.

601,729. DIVING APPARATUS. *William R. Fasey, London, England. Filed March 11, 1897.*

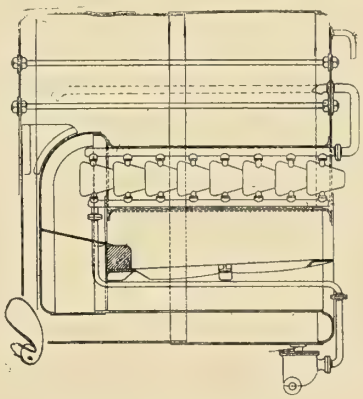
In an improved diving-dress constructed from metal sections, joints connecting the various parts formed from a hemispherical socket on one part, and a hemispherical enlargement on the adjacent part fitting into the socket closely, flanges limiting the motion of the parts and packing forming a water-tight joint.

In an improved diving-dress formed from metal sections connected together, the combination with ball-and-socket joints at the elbows, hips and knees and leather packing in the joints, of flanges on the shoulder-piece, an enlargement at the top of the upper arm-piece, channeled leather packing placed in the groove formed by the enlarged part and a screwed ring completing the joint. In an improved diving-dress constructed from metal and made in sections connected together, joints for the elbows, hips, and knees, formed from a hemispherical socket on one part, a hemispherical enlargement on the adjacent part pivoted to and fitting closely in the socket, flanges on the inside of the socket and on the enlargement and limiting the motion, packing formed from a channeled leather ring placed in the joint and a screwed ring fixing the packing in place. The combination with a metal body-piece, a head-piece screwed into the top of the body, upper and lower arm-pieces and upper and lower leg-pieces all constructed from metal of ball-and-socket joints for the elbow, hips and knees formed from hemispherical enlargements on the ends of the parts pivoted together flanges on these enlargements channeled leather packing-rings and screwed rings holding the packing in place, and shoulder-joints formed from flanges on the shoulder-pieces, enlargements on the upper ends of the arm-pieces leather packing-rings in the channel so formed and screwed rings completing the joint.



599,854. STEAM-BOILER FOR MARINE ENGINES. *Edward Makin, Jr., Manchester, England. Filed May 20, 1897. Patented in England August 6, 1896.*

In combination with the boiler, a steam-generator comprising a series of hollow-walled cones with pipe connections, and a steam-superheater comprising a



MAKIN MARINE BOILER.

series of hollow-walled cones with pipe connections, said generator and superheater being confined within a fire tube or tubes, as described.

NEW PUBLICATIONS.

ETUDES SUR LA MARINE DE GUERRE. Reprinted from the Revue des Deux-Mondes, with additions, and six warship plans and three maps. Berger-Levrault & Cie., Libraires-Editeurs, Paris, 5, Rue des Beaux-Arts. Size, 5 1-2 by 9. Pages, 311. Paper covers, 5 fr.

This volume is a collection of five essays on naval strategy and allied subjects published in the *Revue des Deux Mondes* between 1889 and 1897. The topics treated are as follows: Naval Strategy, Naval Tactics, Cruisers and Scouts, The German Ship Canal and Modern Fleets, The Logical Constitution of the French Naval Force. In the first essay the fundamental principles of all strategy are discussed, and particular applications are made to the conditions affecting naval warfare. Use is made of historical illustrations distributed through the past century, and the point is brought out that while tactics must change with the characteristics of the ship, strategy remains, after all, much the same. The author starts from the central proposition that the chief objective of a naval fleet must be to to meet and destroy the principal fleet of the enemy, and that all naval strategy must take its inspiration from this principle. In the second essay the relations between the characteristics of modern warships and the most suitable formations and evolutions both for cruising and for war are ably and clearly discussed. In the third essay the author presents his ideal of two types of warships, one a commerce destroying cruiser of great endurance, whose rôle shall be to keep the sea for long periods of time in the track of the enemy's commerce, avoiding by superior speed a battle with the enemy's ships of superior armament, and effecting the utmost possible damage in this particular field of naval warfare. The chief characteristics of this ship are as follows: Displacement, 12,000 tons; I. H. P., 30,000; speed, 24 knots; coal capacity, 3,000 tons; armament, one 5 1-2 in. gun forward; twenty-four 4 in. guns, one 8 in. mortar aft, with light rapid firers according to choice. The ram bow and torpedo equipment are omitted, and coal protection is made to do duty for a protective deck. This is intended as a type of vessel entirely specialized and with but one objective—the capture of mercantile ships. Issue might be taken regarding some features in detail, but all will agree that by sticking strictly to her business such a ship should be capable of a vast amount of damage to mercantile shipping of all classes. The author's ideal of a scout ship is developed from the proposition that the place for most effective scouting is near the enemy's fleet rather than near her own, and that as a division the scout ships must provide as nearly as possible a continuous fund of information regarding the location and movements of the enemy. The chief characteristics of such a scout are given thus: Displacement, 6,000 tons; I. H. P., 13,000; speed, 21 knots; coal, 1,200 tons; armament, main battery of 8 in. and 6 in. or 5 1-2 in. guns, with secondary battery to correspond; protection, deck and 4 in. to 5 in. of side armor. This type of scout is therefore a rather small armored cruiser with fair speed and moderate battery power, and is, of course, intended for fighting in the latter stages of a campaign, as well as scouting in the earlier. In the fourth essay the history of the German ship canal is summarized, and its probable effect on the tactics of the German navy is discussed in an interesting and comprehensive manner. In the last essay the author developes his ideal of the French fleet upon the supposition that the combined fleets of the Triple Alliance in the Mediterranean and on the North must be dealt with. The author's development of the subject is interesting and forceful, and he concludes that to fulfil the purposes desired, France should have a fleet of about 650,000 tons of all classes, while in fact the sum reaches to but 480,000 tons. In this essay the designers of some of the recent French ships are taken to task for their apparent sacrifice of offensive for defensive qualities, and here, as elsewhere in the book, the well known principle is insisted upon that to make war is to attack. As a whole, these essays are written in an admirably clear and forcible style, and while one may not always agree in detail with the conclusions reached by the author, it is always a pleasure to read a book where the bases of the conclusions are presented in so clear and forcible a manner. The essays are reproduced without change as they first appeared, and in some details, as stated in the preface, the author has found reason to modify his earlier views, but has preferred to present them as originally written in order to show the development of the subject in his own mind. Several notes at the end of the volume bring the older essays down to date, however, and thus make of the book, as a whole, a presentation of the subject from the latest points of view. Plans of several warships of the French and other navies are given in illustration of some of the types of ships, as well as maps of the German ship canal. The last word on naval strategy and tactics seems still a long way off, longer, perhaps, since the events of the immediate past in the Spanish-American war than it seemed before. Just what the final teachings of the past few months may be it is too soon to consider at present, but one of them, at least, is that naval strategy can never be entirely worked out on paper nor developed independently of experience in actual sea battles. But while this is true it is none the less desirable that these problems should be constantly studied and that books should be written and read, for this means thought and preparation for a more intelligent analysis and use of such facts of experience as may from time to time be provided.

A MANUAL ON LAYING OFF IRON STEEL AND COMPOSITE VESSELS. By Thomas H. Watson, Lecturer on Naval Architecture at the Durham College of Science, Newcastle-upon-Tyne, England. Longmans, Green & Co., New York and London. First Edition, 1898. Size, 6 1-2 by 10. Pages, 160. With Numerous Illustrations. Cloth, $5.00.

This work, to quote from the preface, was written to meet a need amongst junior ship draughtsmen, apprentice loftsmen and class students. The subject of mercantile vessels is first taken up, and the entire field is covered in twelve chapters under the following heads: Laying off the sheer draught on the loft floor, Cant frames, decks, floors and double bottoms, Shell plating, Scrieve boards, Ribbands and harpins, Moulds, Poop round and turtle back, Expansion of Stringer plate and beam knees, Iron and steel masts, Miscellaneous. Warship design is then taken up, and, to avoid repetition, the discussion covers only the essentially peculiar features, such as protective decks, belt armor, turrets and barbettes, bilge keels, ram bow, inner bottom, etc. Such special points of difference as may arise in composite and sheathed vessels are also treated in separate chapters. As a whole, this work forms the most extended treatise on this special field of ship design with which we are acquainted. The text, though in condensed style, has been prepared with care, and the subdivision into chapters and subheads, together with the index, make it convenient of use for miscellaneous reference. The illustrations, which form naturally an especial feature in a book on this subject, are copious in amount, selected with judgment, and prepared with care. The author presupposes naturally considerable acquaintance with the operations of general drawing and with ship construction, though he is careful to define most of the more important technical terms as they are introduced. The

special knowledge assumed, however, is not more than should be possessed by those for whom the book is intended, and all such should follow the author without difficulty. It is safe to say that any one who works through the book intelligently should be well equipped to deal with all problems likely to arise in the geometrical part of ship design. The book represents more especially the practice on the Northeast Coast of England; but the range of illustration is wide; many alternate methods are given, and such differences as may exist between the methods here given and those in vogue at other places only relate to matters of minor detail, and for the student especially they are therefore quite unimportant. The laying off of ships is, of course, but a special application of descriptive geometry, or of the simple theory of projections to the particular problems arising in the geometry of ship design, and there is much in the book that would be unnecessary to the well-prepared class student. For the latter a good grounding in descriptive geometry and a proper acquaintance with practical ship construction leave little beyond the points of practical technique to be supplied in a treatise on laying off. For the other classes for which the book was designed, however, such is not the case, and the more comprehensive treatment becomes appropriate. In any event it is well that there should be a book giving a comprehensive treatment of this subject, and all interested in the solution of mould loft problems may be congratulated on having so excellent a compendium of practical and reliable methods placed within their reach. The book is well printed on excellent paper, and the entire make-up shows both care and skill on the part of the publisher. The combination of so many folding plates with the text makes the binder's task one of unusual difficulty, but it has been successfully accomplished, and both author and publisher may be congratulated on the production of so thorough and comprehensive a work in a field which has hitherto attracted so little attention from the writers of books.

MANNING'S YACHT REGISTER FOR 1898, *with which is incorporated The American Yacht List.* In two parts, with colored plates, showing Yacht Club Flags and Private Signals of Owners. Thomas Manning, proprietor and publisher, 45 Broadway, New York. Size 8 by 10. Pages 514. Cloth, $10.00.

The latest edition of this valuable reference book, just published, is quite up to the high standard set by the publisher. Part I. contains, among other matters, a register of Recognized Yacht Clubs of the United States and British Provinces; also Lists of Officers, Addresses of Secretaries, Names of Yachts, Official Numbers, Signal Letters, Dimensions, Designers, Builders, and many plates containing facsimilies in chromo-lithograph of Club Flags and Private Signals of Owners. Part II, which contains 196 pages of text, giving particulars of Yacht Club Regattas and Races for 1897, compiled from official sources only. These include Names of Yachts, Racing Lengths, Time Allowance, Club Rules, Weather during Races, Course Distances, Number of Starters, Times of Starting and Finishing, together with Elapsed and Corrected Times and Results, Names of Helmsmen; also a record of the Rules for the America's, Cape May and Brenton's Reef challenge cups. This mass of detailed particulars is properly assorted and arranged for ready reference, the typographical scheme being particularly clear. The mere enumeration of the contents is sufficient to show the value of the work to those interested. It is highly creditable indeed to American yachting interests that anyone should be found who would so enthusiastically undertake this laborious work with such excellent results. No yachting or marine library can be complete without this yacht register, which, considering the necessarily restricted sale of such a work, and the splendid manner in which it has been put out, is sold at a remarkably low price.

RECENT PUBLICATIONS.

"Triple and Quadruple Expansion Engines and Their Management" is the name given a 250 page book by A. Ritchie Leask, the author and publisher. It is now in the third edition—recently published—and is likely to run into several more. As the name would indicate, the book is thoroughly practical throughout, giving in plain language the suggestions and instructions under the several headings. These are grouped in ten chapters, which commence with a summary of the advantages of using steam expansively, then in turn Packing Rings, Slide Valves, Jacketing and Details of Design, Bearings and Auxiliaries, Boilers and various forms of Draft, Liquid Fuel, Working of Boilers at Sea, Care and Operation of Engines and Boilers and Specifications for Marine Machinery are treated, with much additional matter not here referred to by name. There are about 50 illustrations in explanation of the text. To those not familiar with the more improved forms of marine apparatus the book would be immensely helpful, and those who have had much experience in this direction can find a variety of useful pointers in its pages. Books of this practical character are not numerous, and especially those which are not written over the heads of subordinates who desire to fit themselves for responsible positions in charge of marine machinery. This book will be a great aid to such. The American agents of the publisher are Spon & Chamberlain, 12 Cortlandt street, New York.

"Electric Lighting for Marine Engineers" suggests a particularly useful book covering a field in which many of the older engineers have had no youthful training. The introduction of electric lighting on board ship has been so rapid and extensive that, except in vessels large enough to carry a separate electrical staff, there is real need for knowledge of the principles and practice of electricity. The book is the work of Sydney F. Walker, a distinguished English electrical engineer. It is now in the second edition. It is divided into chapters under these heads: Glossary of Terms, Dynamo Machines, Cables and Branch Wires, Electric Lamps and Fittings, Switches, Fuses and Cut-outs, Measuring Instruments, Faults and How to Remedy Them, Use of Electric Light in Petroleum Ships, and Cargo and Search Lights. The book contains about 300 pages and is of convenient size for desk use. There is a considerable number of drawings and engravings of electrical apparatus. In criticism it might be said of the book that the reader hardly progresses in sufficiently easy stages to correctly comprehend the working of modern generators, and there seems to be an undue amount of space given to fittings. It is a very useful book, however, within its limitations and might well form one of a set of books for constant reference. The selling price is 5s., and the publishers are Whittaker & Co., Paternoster Square, London, E. C., England.

"Drawing and Designing for Marine Engineers," by Charles W. Roberts, member of the British Institute of Marine Engineers, has become a standard work in the special field which it covers. It was written primarily for the education of marine engineers who intended to take the British Board of Trade examinations for certificates, and also for those engaged in marine work who have had no opportunity to gain experience in an engine builders' drawing-room. The general contents include chapters on: Drawing Instruments, Projection of Draw-

ings, Designing Cylinders and Slide Valves, Piston and Connecting-Rods and Shafting, Bed Plate, Condenser, Pumps and Pipes, Screw Propeller, Marine Boiler and Boiler Mountings. There are about thirty illustrations in the text, and twenty plates containing good, bold drawings, in just the style that every progressive engineer would like to be able to send out shop drawings. The book is not as elementary as a novice would desire, but for those who have some knowledge of geometry and a quick perception for graphic representation the book is very valuable. As a book of suggestions for draughtsmen or designers it has special merits. It is very practical and simple throughout, and would not strain the mathematical faculties of the student. The book is desk size, with 182 pages of very clear type. The publishers are Whittaker & Co., White Hart Street, Paternoster Square, London, and the price of the book is 6s.

Among the scientific naval periodicals of the day, which are published by various maritime nations, the Journal of the American Society of Naval Engineers holds a very high position. The completeness of its technical articles on the vessels of our Navy, the high character of the scientific papers printed in it (many of them read at meetings of the Society) and the well arranged mass of information about the mercantile marine and marine engineering matters in general, make this publication of immense present value and invaluable as a work of reference. To facilitate its use for the latter purpose the Society has printed a General Index of the Volumes I to VIII, 1889-1896 inclusive. Within the space of sixty-seven pages the reader is thus put in touch with a whole library of titles of articles, such as are noted in the foregoing. The possession of this general index makes it unnecessary to go through the separate indexes of each volume, and is especially useful to those who have incomplete sets. The index can be had by remitting $1.50 to W. M. McFarland, Passed Assistant Engineer, U. S. N., Secretary-Treasurer of the Society, Navy Department, Washington, D. C.

"Refrigerating and Ice-Making Machinery" has appeared in a second edition with additions. It covers very completely the various systems in use without, of course, special reference to the installation of such apparatus on ships. It is conveniently divided into sections, treating in turn of the general laws which apply to Methods of Refrigeration, the Vacuum Process, the Compression Process, the Absorption Process, the Cold Air System; also Discussion of Fittings, Construction and Arrangement of Cooling Rooms, Industrial Applications, Ice Making, and finally Questions of Cost. The author's style is clear and good, and he has written a book which the average practical man can read and remember. The book contains 280 pages, is a very portable size and is well illustrated. A. J. Wallis-Taylor is the author, and the publishers are Crosby, Lockwood & Son, 7 Stationers' Hall Court, Ludgate Hill, London. The selling price is 7s. 6d.

The Coast Defence Edition of the Scientific American Supplement, just issued, treats of land defences in the same manner as the Naval Supplement covered the sea forces of the United States. It is an exceedingly useful issue, in that it contains inside one cover matter which could only be found outside in a great mass of publications. It treats of guns, armor and fortifications, giving types, methods of construction and operation, armor plate manufacture and tests, and disposition of guns at various coast points. There is also much matter on explosives, torpedoes and small arms, and comparative tables of large breech loaders. The illustrations are extremely numerous and well executed and fully descriptive of the text. Munn & Co., 361 Broadway, New York, are the publishers, and the selling price is 25 cents.

TRADE PUBLICATIONS.

A catalogue and price list of paints, colors, varnishes, etc., is issued by Harrison Bros. & Co., Inc., Philadelphia, Pa. This company also issues a pamphlet entitled, "Chemistry of Paints," which is well worth the reading by users of paint.

A Catalogue of Various Pneumatic Tools, such as riveters, caulking tools, etc., is just issued by the Ridgely & Johnson Tool Co., Springfield, Ill. The various tools are well illustrated, showing them in use for ship work, etc., making the catalogue a very useful one.

"The Confessions of an Oil Fiend" is the title of a 3 in. by 6 in. booklet issued by McVicar & Sweet, Denver, Col. It has much information regarding the McVicar oiler, which every engineer will find worth reading. Copies can be had by mentioning Marine Engineering.

A neatly printed booklet 7 in. square has just been issued by the International Correspondence Schools., P. O. Box 1111, Scranton, Pa. It is printed in red and green, on light green paper, and gives a great deal of information valuable to all of those interested in technical education, and explains in detail what correspondence instruction is.

The Davidson Fan Wheel, for purposes of ventilation, etc., is well illustrated in a twenty-eight page neatly bound and well printed catalogue just issued. Many illustrations and tables in connection with the reading matter make the contents complete. Copies of the catalogue can be had from the Massachusetts Fan Co., 53 State St., Boston, Mass.

"Graphite as a Lubricant Scientifically and Practically Considered; Also, Its Value as an Accessory for Engineers and Machinists." The sixth edition of this pamphlet revised and brought up to date has just been issued by the Joseph Dixon Crucible Co., Jersey City, N. J. It comprises thirty-two well filled pages and contains much valuable information on the subject in question.

A series of bulletins regarding electrical machinery is issued by the C. & C. Electric Co., 143 Liberty St., New York, the last three being devoted to bipolar dynamos and motors, ironclad dynamos and motors, and multipolar dynamos and motors. These bulletins are very handsomely printed and contain much valuable information. Copies can be had by referring to Marine Engineering and sending to the company.

"The Paint Question" is fully discussed in a 4 in. by 8 in. pamphlet of 30 pages. It is intended to be a practical treatise on the selection and use of paint and is written by Stanton Dudley, author of "Paint Talks." The reading matter is carefully arranged under headings, and a table of contents is given for ready reference. Users of paint should send for a copy of this to the New Jersey Zinc Co., 52 Wall St., New York.

"Air Compressors" is the latest catalogue issued by the Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York. It is 6 in. by 9 in. in size and contains about 100 pages, finely printed in red and black and with complete index. Compressed air has become so generally used in ship yards for operating hand tools that a complete catalogue like this will be much appreciated. It is fully illustrated, showing every type of compressor.

The Foster Engineering Co., Newark, N. J., has just published a catalogue of the various "Foster" devices, including reducing valve, pump speed governors regulator valves, etc. The catalogue is 6 in. by 9 in. in size, of sixty-four pages and contains many illustrations of the various devices referred to. The cover is printed in black and gold and has a large embossed cut of the "Foster" valve. There is much in this catalogue to interest every man connected with steam engineering.

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

REDUCING VALVES

to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.

BUSINESS NOTES.

NEW YORK HEADQUARTERS.—An office and storeroom of the Eynon-Evans Mfg. Co., Philadelphia, has been opened at 107 Liberty St., New York, where can always be found a full line of injectors, bilge pumps and many other specialties manufactured by this company.

MARINE HARDWARE.—Owing to the great extension of its business, the Enos Sheet Holder Co., Peabody, Mass., has been organized into a stock company with $60,000 capital stock, and during the coming season will be even better prepared than ever to handle business promptly.

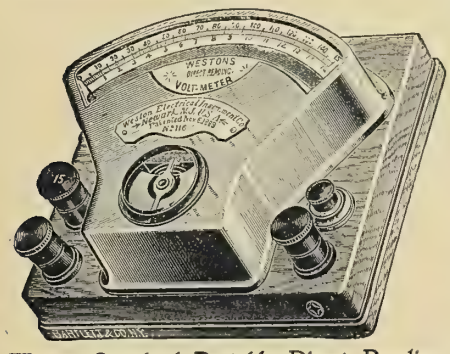
PIPE WRENCHES.—The twelve river steamers illustrated in the July number of Marine Engineering before launching at Moran Bros. shipyard, Seattle, Wash., were all fitted out with Vulcan Chain Pipe Wrenches furnished by J. H. Williams & Co., 9-31 Richards St., Brooklyn, N. Y.

A MODEL MARINE ELECTRIC PLANT.—Those of our readers interested in electricity should send for a small picture of a very attractive electric plant. The dynamo is the Riker manufactured by the Riker Electric Co., 45 York street, Brooklyn, N. Y., and the engine is a Wellington made by the Fore River Engine Co., Weymouth, Mass.

NEW PROPELLER WHEELS.—The "Perfect" propeller wheel, designed by Captain Samuel Golden, 178 Ohio St., Buffalo, has recently been given a test. The Buffalo police boat was equipped with one, and Captain Pritchard of the boat says it drives the boat faster than before and has greatly reduced vibration, even when the engine is working to its full capacity.

GOOD BUSINESS REPORT.—The manufacturers of the Lee injector and other steam specialties write us that when they started their factory a year ago they put in a six H. P. engine, but owing to the rapid growth of their business in all parts of the United States, Canada, British Columbia and Mexico, they have been compelled to add new machinery and tools and replace their six H. P. engine with a 20 H. P. The manufacturers are the Lee-Penberthy Mfg. Co., Detroit, Mich.

MARINE RAILWAYS.—It may not be generally known that the Halifax, Nova Scotia Graving Dock Co., in whose fine dry dock the Battleship Indiana was docked some time ago, has at the same port also a fine marine railway plant, consisting of four marine railways, all of which were built by the firm of H. I. Crandall & Son., East Boston, Mass. The capacities of these range from 150 tons to 2,700 tons weight, and they handle from 500 to 550 vessels per year. The largest railway, of 2,700 tons capacity, was built in 1863, and Messrs. Crandall & Son are about to start the work of rebuilding it and putting it in up-to-date condition.



Weston Standard Portable Direct Reading Voltmeter.

WESTON STANDARD PORTABLE

DIRECT READING

VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Intruments are recognized as **THE STANDARD** the world over. Our **STATION VOLTMETERS** and **AMMETERS** are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.,
114-120 William St., NEWARK, N. J., U. S. A.

A Fine Display of Pumps.—At the present electrical exhibition in Philadelphia one of the finest exhibits was of Worthington pumps made under the auspices of the Philadelphia agents, Messrs. Fred and William Doran, who have offices at 724 Arch St.

Metal Polish.—The Imperial Metal Polish manufactured by the Rath Mfg. Co., Philadelphia, is handled in the New York market by William E. Burton, 18 and 20 Liberty St., who carries a large supply at all times and is ready to answer any inquiries.

Propeller Stern Pipe Packing.—The packing of the propeller stern pipe has been a difficult piece of work and is believed to be overcome by the use of the rawhide packing manufactured by the Mabbs Hydraulic Packing Co., P. O. Box 829, Chicago, Ill. Water is the best lubricant for rawhide and makes it anti-frictional. This packing has stood years of tests and is easily applied. Full information and circulars may be had by applying to the company.

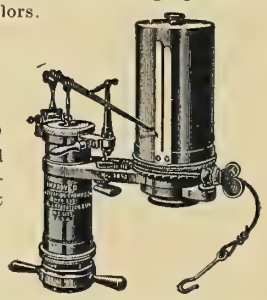
SEND 2 LABELS

cut from front of boxes of EUREKA PACKING and we will send you a pack of beautiful playing cards. All being special in 3 colors.

MARINE ENGINEERS

should own an INDICATOR and know how to use it. Send for circular and *special* prices. It will interest you.

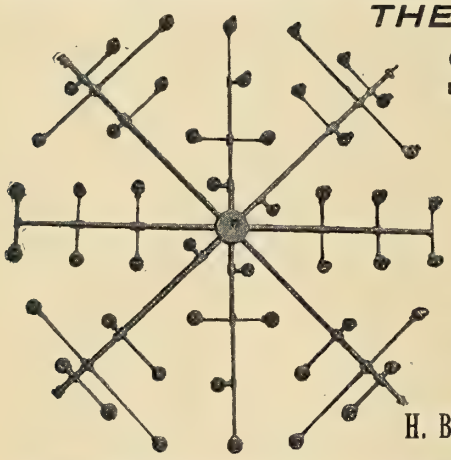
Jas. L. Robertson & Son,
218 Fulton St., N. Y.



THE IMPROVED ANNULAR

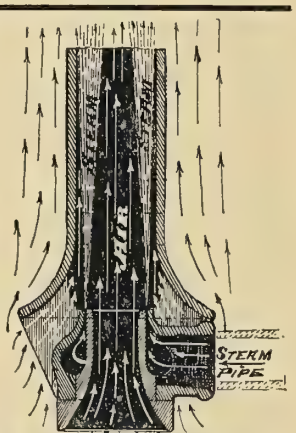
STEAM JET.

POWERFUL—ECONOMICAL.



Gives draft equal to a fan. Can be applied to any stack, and will greatly increase the draft with a minimum amount of steam. Cuts show section of a jet and spider to which they are attached.

Send for circulars and list of steamers on which it is used.



Section of Jets

H. BLOOMSBURG & CO., NEWPORT NEWS, VA.

Northern Steamship Co.

Office of the Agent.

Buffalo, N.Y. Oct., 8, 1897.

Regal Packing Co.,

Chicago, Ill.

Gentlemen:-

Replying to your inquiry as to the merits of your Regal Metallic packing as shown by its use on the Engines and other machinery of the Steamship North West, it gives me pleasure to report that it is giving unqualified satisfaction in every place where it has been applied.

We are now using it in the stuffing boxes on one of our main Quadruple Expansion Engines (of 3000 H.P.), as well as in our pumps, injectors, etc., which operate in connection with our Belleville Boilers, and also in other places where packing of unusual character is required against high pressures, or to endure severe service either for water or steam.

We carry 267 lbs. boiler pressure and steam at 200 lbs. is delivered to our high pressure cylinders. This will afford some idea of the character of the packing we require, and I am pleased to state that your Regal Packing has met this demand perfectly.

As a matter very important to Engineers, your packing contains a lubricating element which is constant, and for that reason there is a very appreciable reduction in the amount of friction on all rods and stems and a consequent reduction in the amount of wear thereon.

I sincerely believe your Regal Metallic packing superior to anything I have known and its economy is unquestioned since it can be used over and over again for all time. I have nothing but good words for it, and I am sure every Engineer will use nothing else when once its value is understood.

Very truly yours,

John A. Currier
Chief Engineer
Str. North West.

I take pleasure in endorsing the above
Meiers Goryell

REGAL Metallic Packing.

Descriptive booklet sent on application.

Regal Packing Company,

Fisher Building, Chicago, Ill.

ZINC FOR THE HULLS OF VESSELS.

In painting the hulls of ocean going vessels two purposes are in view; the first to protect the material from corrosion and the second to resist the destructive attacks of marine life. To accomplish the first-named purpose, the coating applied should be as impervious as practicable to water, and as resistant as possible to the chemical action of the marine salts. The second named object is attained to a certain, not altogether satisfactory, extent, by the use either of poisonous materials (copper, arsenic, carbo ates, etc.), or by the application of a material too soft to afford a secure lodgment to the parasitic growths.

The most satisfactory of the water and chemical resisting media is oil, as is evidenced by the time-honored practice of giving to iron ships' plates a preliminary bath of hot linseed oil. On the value of this first coating, experts practically agree, but in regard to the subsequent treatment there is a great diversity of opinion, with the preponderance perhaps in favor of red-lead. Logically, however, no form of lead paint appears to be naturally adapted to this use, as the lead compounds are all subject to decomposition by sea water, all carry a relatively small proportion of oil in combination, and all, more or less, form with linseed oil, a compartively soluble metallic soap. Perhaps these defects would have impressed themselves more effectually upon the minds of ship-building authorities had it not been the general custom to shield the coatings of lead paint with a final coat of more resistant material.

A paint made with red-lead carries to the painted surface a very small proportion of oil, and therefore the particles of lead-oxide are imperfectly protected against chemical action, to which it is very subject, being strongly basic. Zinc-white, on the other hand, carries a higher percentage of oil 48 to 50 per cent.) than any other pigment available for the purpose, does not saponify the oil, and is chemically inert under all marine conditions. It also retains its pure white color indefinitely, and these qualities probably account for its adoption by the United States Government for painting the famous "White Squadron."

If red-lead be used on ships' hulls, it should be protected with a sufficiently heavy coating of zinc-oxide, or, perhaps better still, the lead should be combined with about 50 per cent. of zinc, and the protective covering of zinc-white, either pure or tinted with stable mineral colors, should be laid on over the combination paint.—*Adv.*

STANTON DUDLEY.

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

EXPERIENCED MAN SEEKS POSITION.

Marine engineer, with long and extensive practical experience in the construction and operation of modern high-power marine machinery, desires position with ship and engine builders. Can design and lay out work. Address I. H. P., MARINE ENGINEERING, World Building, New York.

PROFESSIONAL CARD.

H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.

Manufacturer of **Screw Propellers** for Usual and for Special Work.

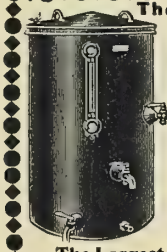
The Allen Dense Air Ice Machine for Steam Vessels.

41 MAIDEN LANE, NEW YORK.

WELLS LIGHTS IN WAR TIME.—Since war operations began, the Wells Light Mfg. Co., 44 and 46 Washington St., New York, has been busy making shipments of lights to various places to meet the needs for brilliant and efficient illumination at fortifications, for coast line defence, etc., which they completely fill. This company has also made a large consignment of lights to Cuba within the past few days, as the Wells Light has proven itself to be one of the very necessary outfits of the war.

MECHANICAL DRAFT.—Travellers passing through Jamaica Plain, Mass., look at the large manufacturing establishment of the B. F. Sturtevant Co., and wonder at the disappearance of the tall boiler chimney, which previously stood as an evidence of so much invested capital. It had, however, outlived its usefulness, and its value was measured only by the possible utilization of its bricks, for a substitute had been installed in the shape of a Sturtevant fan for providing the draught. The invisible products of combustion are now diischarged through a small stack extending such a short distance above the boiler house as to be hardly noticeable.

REDUCED COAL CONSUMPTION.—Last winter the whaleback steamer Thomas Wilson was taken in hand by the Detroit Dry Dock Co., Detroit, Mich., and without other alteration of her machinery the Howden hot draft system was applied to her boilers. Scientific trials were made before the change and afterwards, as assurances were given that a saving in fuel could be made of 15 per cent. The consumption of fuel last year was 2.3 pounds per indicated horse power per hour. Under the assurances it was necessary to reduce the fuel consumption to 1.95 pounds. After the change careful tests were made and it was shown that the fuel consumption was reduced to 1.643 pounds, showing an improvement of 25 per cent. over what the steamer had been doing. It is evident from these figures, which are official from the Dry Dock Co., that the new system would pay for itself in a short time, when properly installed.



The **CROSS OIL FILTER**

actually reduces oil bills 50% or more. Sent on approval. Used in 17 countries. Adapted to steam vessels of every description. Send for circulars, testimonials, etc.

THE BURT MANUFACTURING CO.

AKRON, OHIO, U. S. A.

The Largest Manufacturers of Oil Filters in the World.

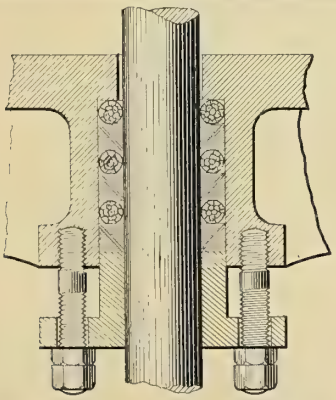


Fig. 1—Packing in position and gland adjusted.

DANIEL'S PATENT P. P. P.

Diagonal Rod Packing.

The most elastic and durable packing for feed pumps, air pumps, hydraulic pumps, and trunk plunger pumps, also for electric engines and all other auxiliary engines and pumps. Special grades for high steam pressures on main engine rods and valve stems, also for ammonia compression pump rods.

Send for sample. Will not score the rods. Manufactured only by

C. A. DANIEL,

409 Market St., Philadelphia, Pa.

Branch Offices: Pittsburg, 105 Water St.; San Francisco, 514 Mission St.; Chicago, 4 S. Canal St.; Toledo, 638 Leonard St.

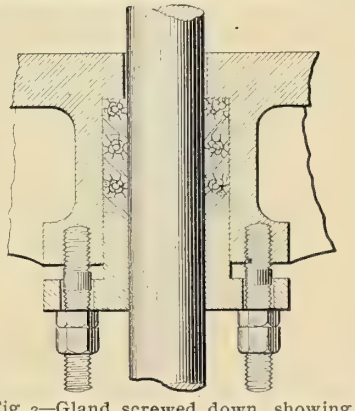


Fig. 2—Gland screwed down, showing how the wedges slide up to compensate for wear.

RAINBOW PACKING

Makes a Steam Joint Instantly.

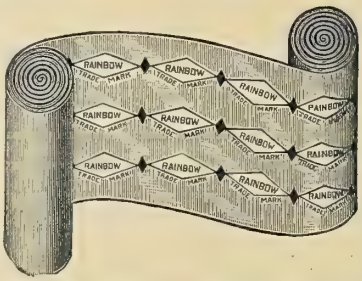
HONEST JOHN.

MR. JOHN H. DEMING.
General Superintendent Peerless Rubber Manufacturing Co.

THE COLOR OF RAINBOW IS RED.

NOT AFFECTED BY OILS, AMMONIA LIQUORS, STEAM HEAT OR ALKALIES.

None genuine without the Trade-Mark.



RAINBOW PACKING HAS 3 ROWS OF DIAMONDS IN BLACK EXTENDING THROUGHOUT THE ENTIRE LENGTH OF EACH AND EVERY ROLL.

Fac-simile of a Roll of Rainbow Packing.

Who invented and who is the only man in the world who can make or ever has made

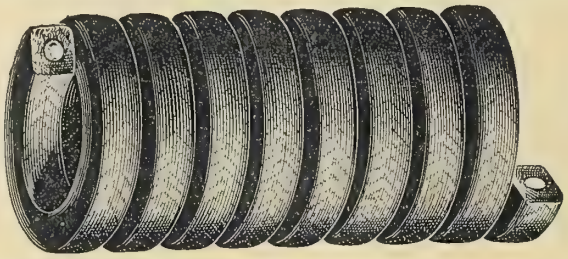
Rainbow Packing.

RAINBOW GASKETS are especially adapted for Low Pressure Steam and Hot Water Heating Apparatus.

PEERLESS DISCS for Russell, Frink, Walworth, Jenkins, Lorain and Kelly & Jones Valves.

"HONEST JOHN."

Made in both Straight and Spiral Form.



Once Tried, Always Used.

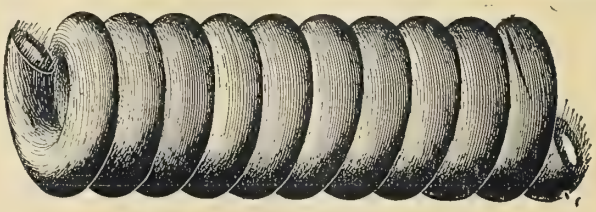
Put up in Boxes.

HYDRAULIC RAINBOW CORE PACKING.

The Best Hydraulic and Cold Water Packing in the World.

Hercules Combination.

Always Tight. Leaves the Stem Clean.



Will Hold 400 lbs. Steam.

Metallic Stop Valve Packing.

SEND FOR CATALOGUE.

Patented, Copyrighted and Manufactured Exclusively by

THE PEERLESS RUBBER MANUFACTURING CO.,

16 Warren Street, New York.

16-24 Woodward Ave., Detroit, Mich. 202-210 So. Water St., Chicago, Ill.
17-19 Beale St., and 18-24 Main St., San Francisco, California.

MARINE ENGINEERING.

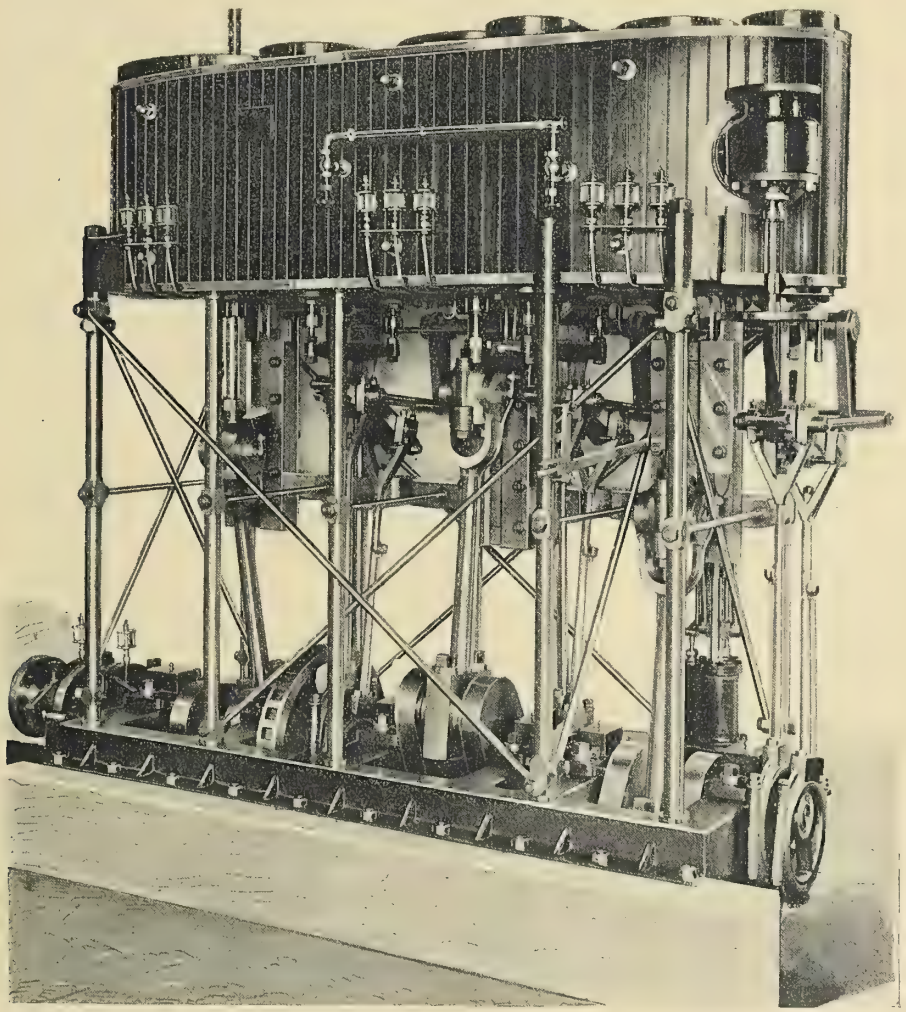
Vol. 2. NEW YORK, SEPTEMBER, 1898. No. 9.

D.S.E.

MODERN TYPE OF VERTICAL-INVERTED TRIPLE-EXPANSION MARINE ENGINE.

We here show an illustration of an extremely handsome high-class triple-expansion marine engine of a type which is largely being turned out now for small vessels. This particular engine represents a standard type adopted by the Fore River Engine Co., of Weymouth, Mass. It has cylinders 9 in., 14 1-4 in., and 23 1-2 in. dia. by 14 in. stroke.

The cylinders with their valve chests and receivers, are of hard close grained cast iron, each cylinder with its valve chest being cast separately, and securely bolted together.



MODERN TYPE OF TRIPLE-EXPANSION MARINE ENGINE.

Copyright, 1898, by The Marine Publishing Co., New York.

The stanchions or frames supporting the cylinders are of open hearth machinery steel, accurately turned to fit reamed holes in the cylinder lugs and bed plate. All frame holes in the cylinders and bed plates are drilled through a jig, enabling duplications of these parts at any time, and also ensuring perfect alignment when the engine is erected. The crankshaft is of open hearth machinery steel of the built up type, this being one of the special features of the Fore River engine. After all parts of the crankshaft are completely finished, it is put together, and trued up simultaneously, to a perfect alignment, and in no instance are the shafts or pins returned.

Connecting rods, piston rods, links, eccentric rods, cross and diagonal braces are of open hearth steel and highly finished. All bearings are lined with special white metal, adapted for use in crankshaft and crankpin bearings.

The pistons are of cast steel with followers and cast iron spring rings. All the valves are of the piston type, one for the high pressure, two for the intermediate and two for the low pressure cylinders. The valves are actuated by Stephenson link-motion valve gear with links of the double bar type, having all wearing parts adjustable. The valve stem guides are arranged with adjustable gibs having large wearing surfaces.

The crossheads are of the slipper type of cast bronze with large wearing surfaces. The crosshead guides are of cast iron and arranged for water circulation.

The engine is handled by a steam reversing gear having steam and oil cylinders, with operating handles on the front of the engine. There is a complete system of oiling enabling all the running parts to be supplied with oil when the engine is in motion.

The thrust bearing is attached to the after end of the engine bed in such a manner that constant alignment is assured.

The bracing is of the most efficient form and all parts of the engine are easily accessible for adjustment or repair.

The Holland-America Line's new twin-screw steamer Statendam, built by Harland & Wolff, at Belfast, arrived at Rotterdam from Belfast late last month. On the passage the engines worked very smoothly, and a speed of 16 1-2 knots was attained. The Statendam is 530 ft. long, 60 ft. beam, and 43.6 ft.. deep, giving her a gross tonnage of nearly 11,000 tons. In addition to the steamer's large cargo capacity she has accommodation for 200 first-class, 150 second-class, and a large number of steerage passengers. The Statendam is the second of five new twin-screw steamers, which the Holland-America Line is building for a weekly passenger and freight service. The Rotterdam was the first of the new steamers.

MARINE GASOLINE AND GAS ENGINES AS USED IN MODERN MOTOR BOATS.—III.

BY CECIL H. PEABODY, M.E.

Having inquired into the general principles and methods of running gasoline engines, let us now consider their application to propelling boats and launches. Anyone who has experienced the delay in getting up steam on a steam launch and seen the engineer watching the steam gauge and feeding the fire, can understand at once the advantage of a motor which can start at full power at a moment's notice and which has no boiler or furnace. The absence of a boiler leads incidentally to an advantage of great importance for small boats in that no engineer's license is required.

There seems also to be greater control over the location of the engine in the boat; for very small boats there is a great advantage in placing the engine right aft, and thus leaving the body of the boat for the passengers. This is well illustrated in Fig. 6, which shows very distinctly the longitudinal section of a 16-ft. launch built by the Racine Boat Manufacturing Company, and fitted with a one horse-power motor which is expected to give a speed of 5 1-2 or 6 miles an hour. Fig. 7 gives the general appearance of a 20-ft. launch, which, however, differs only in size and in minor details.

The engine in the example illustrated is placed right aft, so that there is a very short propeller-shaft, and the exhaust from the engine, after passing through a muffler, is turned under the counter so that it causes no inconvenience to the passengers. The engine has an electric ignition with the batteries in a box just forward of the engine. Since the engine with a single cylinder can have only one working stroke for two revolutions, it has a heavy fly-wheel. The engine always runs in one direction and the boat is reversed by turning the blades of the propeller, as will be explained later. Of course, gasoline engines may be used on much larger boats; for example: Fig. 8 represents a 53-ft. twin screw yacht built by the Daimler Motor Company. Gasoline engines appear to be exceedingly well adapted for auxiliary power on sailing yachts and vessels, since they may occupy but little space and do not interfere with the working of the vessel under sail. To show that such engines may be used for business as well as for pleasure, an illustration (Fig. 9) is given of a New Zealand schooner fitted with a 20 horse power engine made by the Union Gas Engine Company of San Francisco.

It is imperative that the power for a boat shall always be available. This is true for a steam engine so long as there is pressure in the boiler, for the engine may be started promptly by letting on the steam. On the other hand, there is a certain amount of manipulation required to start a gasoline engine. First the vaporizer must be charged by hand and then the engine must be turned around to draw in and compress a charge of ex-

plosive mixture, which is ignited in regular order by the igniter, upon which the engine should start running. The time required for this appears short at the dock or landing when the boat is made ready for a trip, but it might be long enough to lead to serious consequences if the boat were maneuvered by starting, stopping and reversing the engine. Consequently it is customary to allow the engine to run continuously so long as the boat is in service. Some method must be provided for reversing the power of the engine, and though it is not absolutely necessary, it is advisa-

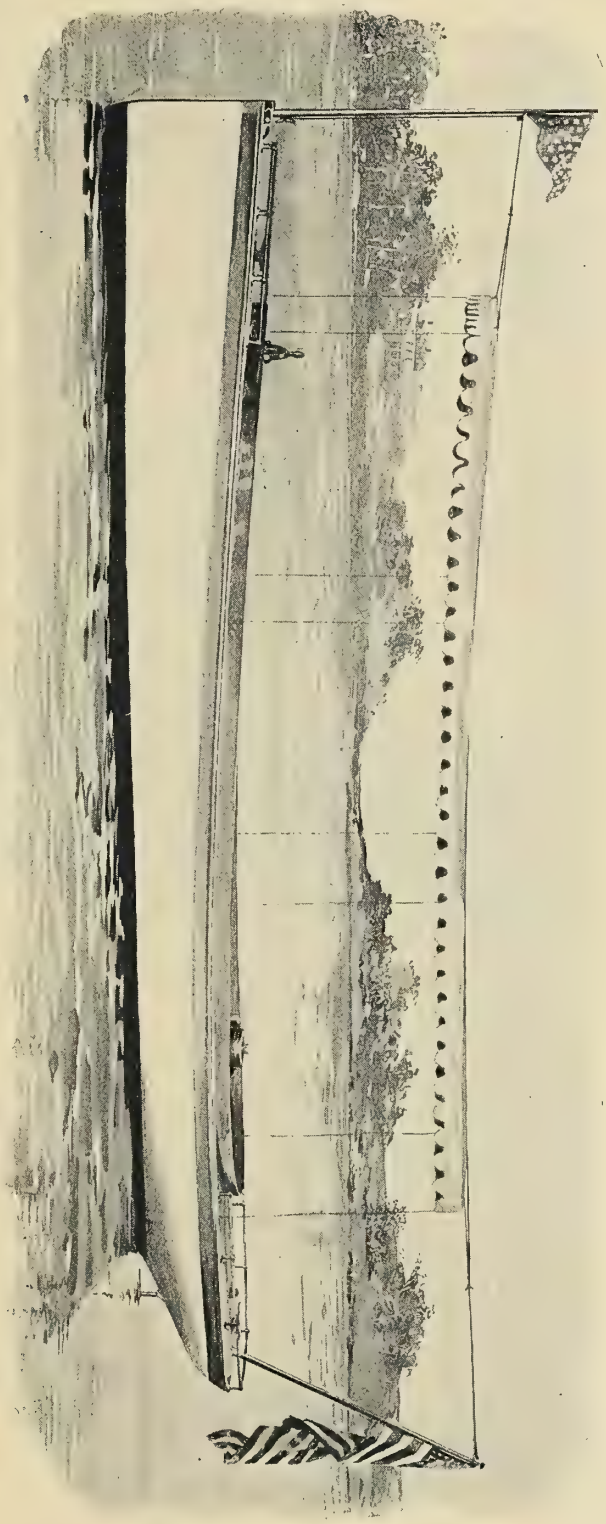


FIG. 7.—25-FT. LAUNCH BUILT BY THE RACINE BOAT MANUFACTURING CO.

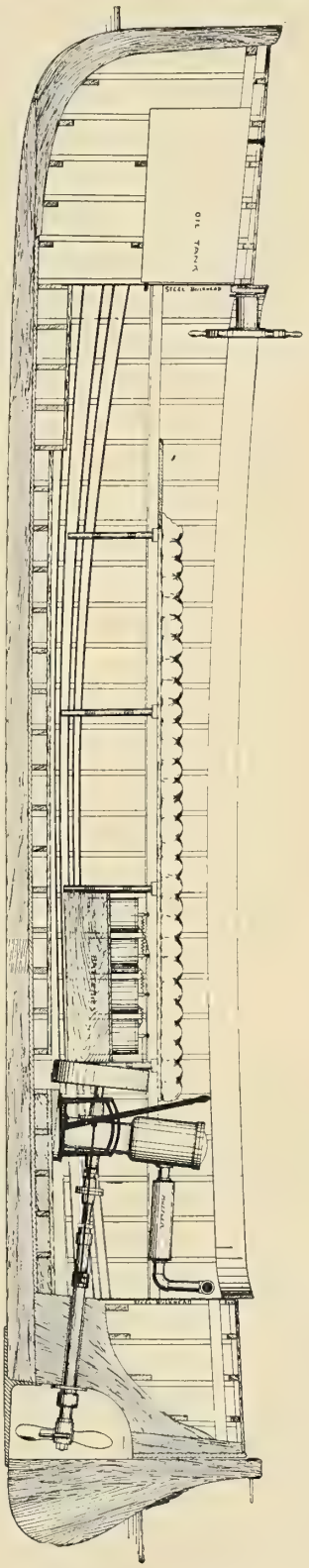


FIG. 6.—LONGITUDINAL SECTION 16-FT. LAUNCH, WITH 1 H. P. MOTOR.

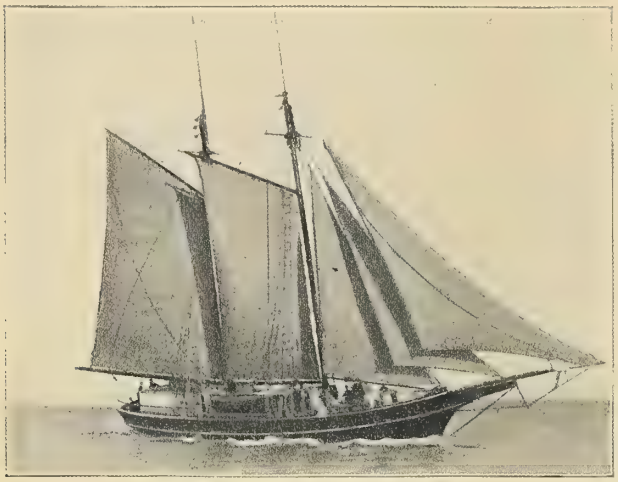


FIG. 9.—NEW ZEALAND SCHOONER.

ble to apply a governor to control the engine when it is running idle or with small power.

There are two ways of reversing in common use; one makes use of some form of gearing to reverse the propeller-shaft, and the other depends upon turning the propeller blades.

Fig. 10 shows the reversing-gear used by the Van Duzen gasoline engine. The main-shaft of the engine carries two spur-wheels, either of which can be made to revolve with the shaft by a clutch which is worked by a vertical lever. The spur-wheel near the engine gears directly with another spur-wheel of the same size on the propeller-shaft below, so that when the lever is thrown forward the boat is driven ahead. When the lever is in the middle position, as shown in the figure, the engine is disconnected from the propeller-shaft and runs freely under the control of the governor. To make the boat go astern the lever is thrown back, and it clamps the other spur-wheel to the main-shaft of the engine. This spur-wheel does not act directly on the corresponding wheel on the propeller-shaft, but it drives it through an idle-wheel on a stud of which the end only can be seen in the figure; the idle-wheel itself is hidden by the standard, which carries the stud and the bearings for the main-shaft and the engine-shaft. When this three-wheel gear is in train the propeller-shaft is reversed and the boat is driven astern while the engine runs in the usual way for driving the boat ahead. The clutches shown in Fig. 10 are clearly friction clutches, as they ought to be, so that the propeller shaft may be started in either direction, gently and without any shock to the machinery.

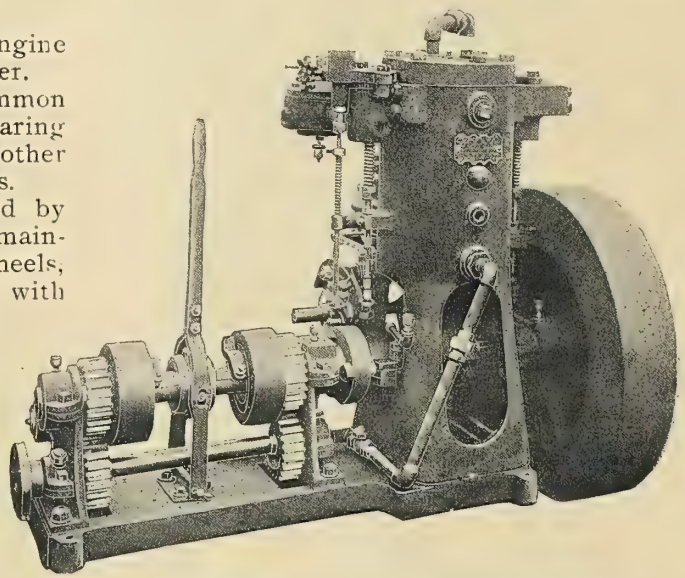


FIG. 10.—VAN DUZEN MARINE ENGINE.

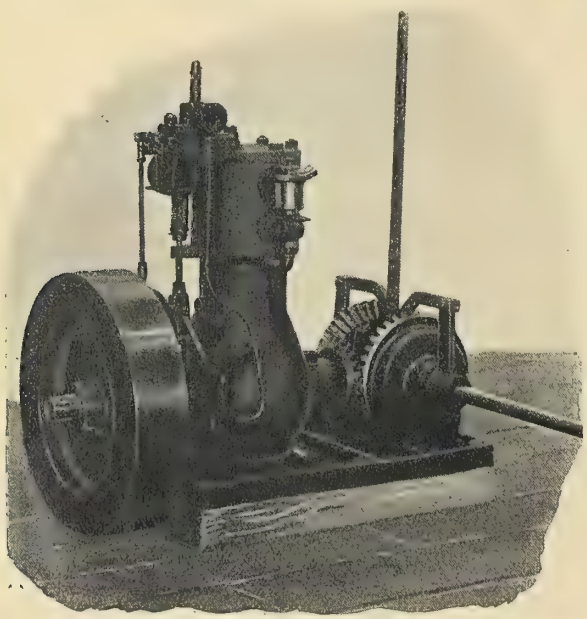


FIG. 11.—4 H. P. WOLVERINE MOTOR.

Another method of accomplishing the same object by the aid of a train of bevel gears is shown in the engraving of a 4 horse power engine built by the Wolverine Motor Works (Fig. 11). Here the engine-shaft carries a bevel wheel which gears with two bevel wheels on a transverse shaft. The two wheels are both loose on the transverse shaft, but either can be clamped to it by a friction clutch that can be thrown by the hand lever which moves transversely. The gear represented in the figure is used by the Wolverine Motor Works for a stern-wheel boat, the paddle-wheel being driven from the transverse shaft by a chain running on sprocket wheels. If such a gear is used for a propeller it may be arranged as shown by Fig. 12, where A is a bevel wheel on the engine-shaft and B is another on the propeller-shaft. C is a bevel wheel set in a disk, or wheel which has a rim *d e* running in a brake-band. In the figure the cylindrical axle on which the wheel turns is represented as carried directly across the brake-wheel. The

hub *f* of the brake-wheel runs on the ends of the engine-shaft and of the propeller-shaft. If the brake-band is drawn back so that it does not touch the brake-wheel the whole mechanism will revolve together, and the boat will be driven forward as though the main-shaft and the propeller-shaft were continuous. But if the brake-wheel is held fast so that it cannot turn, the wheel C will revolve on the transverse shaft, and the wheel B will turn in the opposite direction from A, driving the boat astern. Fig. 12 is intended to give only the general principle of the device, and in practice it will be constructed with different details as required, either for economical construction or durability in service. It is probable that the friction of the wheel C on its its bearing will be enough to keep it from turning when the brake-band is drawn back, but if necessary a friction clutch can be arranged to act when the boat is going ahead, and to be released when going astern, which clutch shall clamp the wheel C to its shaft.

The Daimler Motor Company uses a train of friction cones for running, as is shown by Fig. 13 When the boat is going ahead the small or middle cone is drawn back out of gear and a friction clutch locks the engine-shaft and the propeller-shaft together. When going astern the two shafts are released so that they can turn in opposite directions, and the middle cone is forced up against the two larger cones to drive the propeller in the proper direction to back the boat.

Of the three methods illustrated by Figs. 10, 11 and 13 it is difficult to say which will be most satisfactory, as much depends on the workmanship and the condition of the gear, especially when friction is depended upon for working clutches or for direct driving, as in the last case. Fig. 10 shows the cheaper device, for spur gears are less expensive than bevel wheels or friction cones. The arrangement of bevel gears indicated by Fig. 11 will call for exact and sound workmanship if good re-

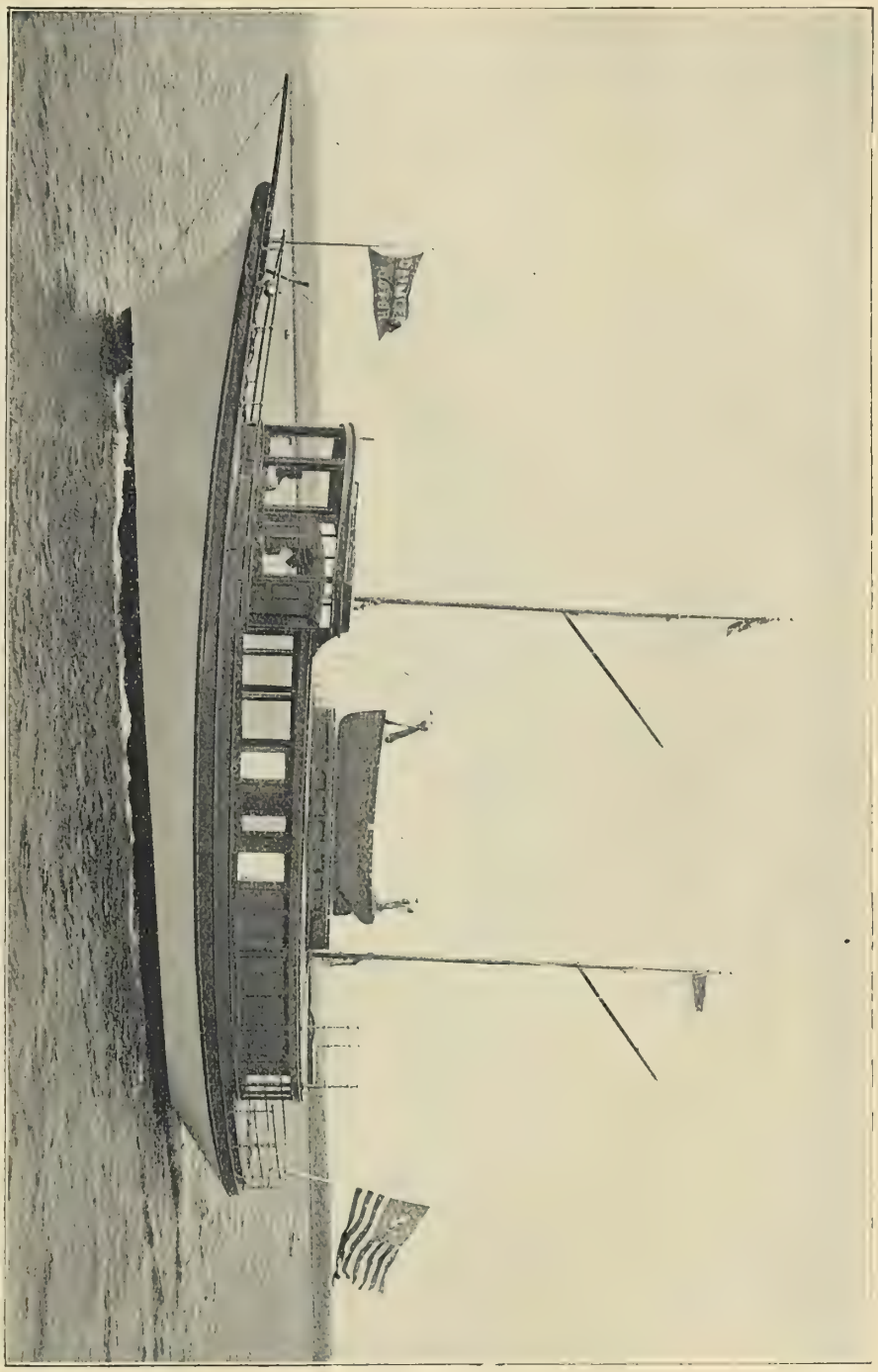


FIG. 8.—53-FT. TWIN SCREW YACHT BUILT BY DAIMLER MOTOR CO.

sults are expected. It appears to be the neatest, and has the advantage that the gear wheels are not in service when the boat is going ahead. The friction cones shown by Fig. 13 are also out of service in going ahead, and this is probably essential to their proper action since friction wheels

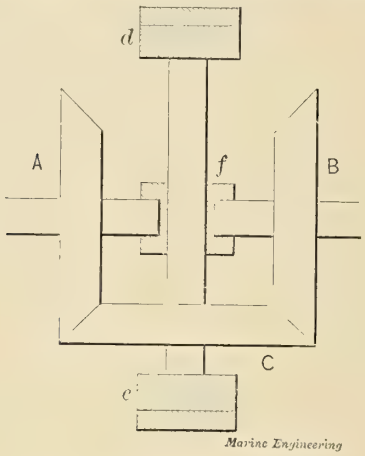


FIG. 12.—REVERSING GEAR.

cannot be expected to do continuous hard work.

The simplest and most compact way of reversing without stopping or changing the direction of rotation of the engine is to twist the propeller blades. Now, twisting propeller blades is a very

sistance or drag of the propeller. The Bevis propeller (Fig. 14) had a large spherical hub with separate blades. Each blade could turn in its seat in the hub and was provided with a crank inside the hub. The propeller-shaft was hollow and through it ran a rod which was connected to

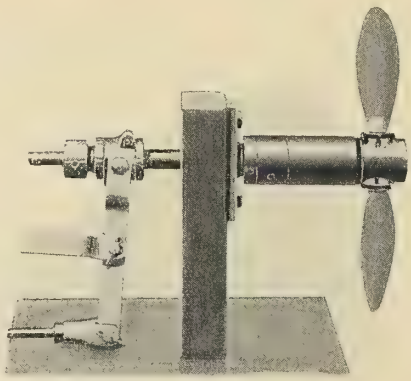


FIG. 15.—REVERSING PROPELLER.

the cranks on the propeller blades. When this rod was forced in one direction it turned the blades into the normal position for driving the ship; when it was forced in the other direction it turned the blades fore and aft so that they offered

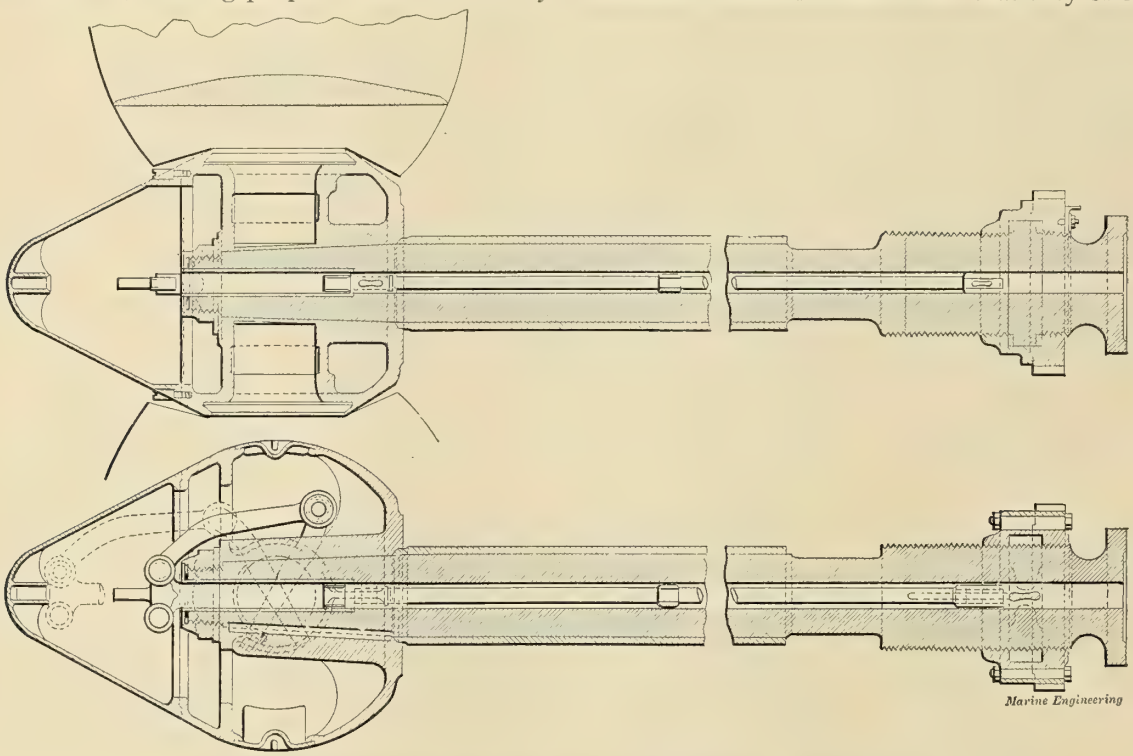


FIG. 14.—CONSTRUCTION OF BEVIS FEATHERING PROPELLER.

old device, invented under the name of feathering propellers for sailing ships with auxiliary steam power. They were primarily intended to turn the blades of the propeller fore and aft when the ship was under sail only, and so minimize the re-

but little resistance to the water. Of course, the blades could also be twisted part way and so alter the pitch of the propeller wheel; but that was a secondary consideration. The inner end of the rod was attached to a cross-yoke that moved in a

slot cut right through the shaft, and this yoke could be moved by aid of a grooved collar that rotated with the shaft. A lever working in the groove of the collar provided a way for moving back or forth the collar, yoke and rod, and thus turning the blades of the propeller while the engine was turning. It is evident that so complicated a device could not be used when much power was transmitted, so the feathering propeller has passed out of service and is not now used even on yachts which depend both on steam and sail.

The feathering propeller has, however, been adopted as a means of reversing gasoline launches, and mechanically is well adapted to the purpose, as it is simple and can readily be made strong enough for the small power required by a launch. Fig. 15 represents the reversing propeller made by the Grand Rapids Gas Engine and Yacht Company. The figure is clearly for illustration and represents the stern part of a boat with the bearing for the propeller-shaft. The shaft has a collar that can be moved back and forth and out upon a rod inside the shaft. The propeller blades can turn and are moved by the rod which acts on cranks inside the hub. The details are not shown by the figure; it is to be regretted that the makers of gasoline engines have not yet arrived at the place where they can exhibit details of their machines more freely.

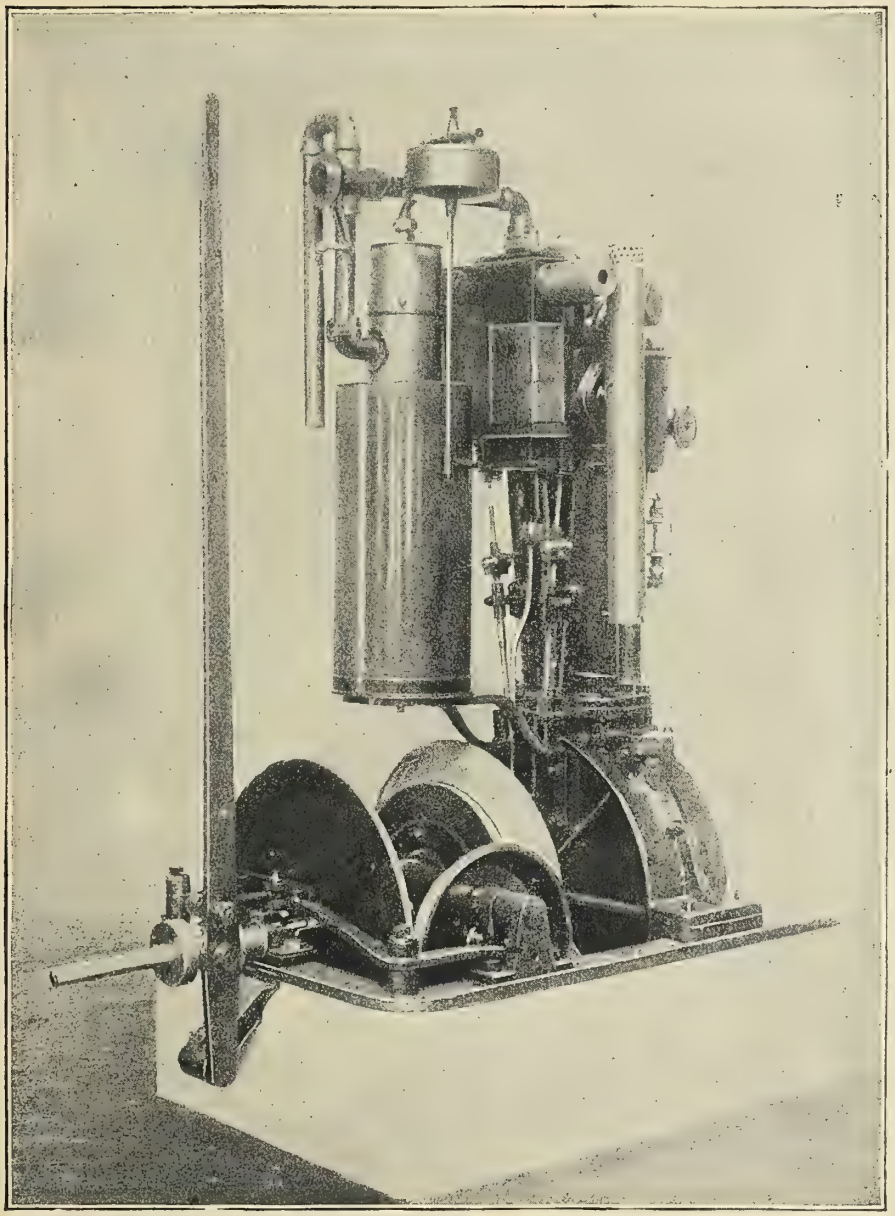


FIG. 13.—DAIMLER MOTOR WITH REVERSING GEAR.

In considering the action of a reversing propeller it must be remembered that the propeller blade has, or should have, a true mathematical surface like that of the thread of a screw. Now a right-handed screw is essentially different from a left-handed screw, and a part of the surface of the right-handed screw —no matter how small it may be — cannot be made to fit a left-handed screw. If the reversing propeller was intended to work equally well in either direction its blades ought to be flat; but such a propeller would lose half of its efficiency as compared with one having properly shaped blades. Reversing propellers are, in fact, made with the blades properly shaped for going ahead, and, when twisted around to go astern they are less than half as efficient as when going ahead. But any screw-propeller is less efficient when backing than when going ahead because it is then at the wrong end of the boat and is unfavorably affected by the rudder. Consequently we may expect to find that a reversing propeller is very inefficient when backing. This is of less importance for a light boat that can be fended off,

but is a great inconvenience, if not a danger, for a large boat.

It is probable that either a reversing gear or a reversing propeller will work well enough for a small boat. For a large boat it appears advisable to be able to reverse the engine. The Wolverine Motor Works make an engine which can be reversed while running and without turning it by hand, as represented by Fig. 16, with the flywheel removed for showing the running-lever. This engine has two cylinders and has an explosion in each cylinder for each revolution, the explosive mixture being lightly compressed in the crank end before being introduced in the cylinder, as described in Fig. 3 of the previous article in the August number of MARINE ENGINEERING. By this method the engine becomes equivalent to a single-acting steam engine, and two cylinders are equivalent to an ordinary double-acting steam engine. It can hardly be considered that two cylinders will avoid stopping occasionally on a dead center, though that may not be very important for a small engine. Some of these engines have three cylinders, and are equivalent to a three-cylinder single-acting steam engine, and may be expected to start promptly when arranged with their cranks at 120 deg. It is interesting to note that six cylinders would be required to give a like effect if each cylinder has only one explosion in two revolutions, as has been found most advisable for gas engines. If gasoline or any form of gas engine is ever used for large ships, there will be little trouble in providing a sufficient number of cylinders for smooth running.

Thus far we have considered only gas engines or gasoline engines, and the latter differ from the other only in that the combustible gas is made as it is used. In order that this can be done easily, a volatile fluid like gasoline is chosen. It must be remembered that a volatile liquid like gasoline vaporizes freely at the ordinary temperature of the atmosphere. If any of it is spilled it quickly dries off, and a little vaporizing on the hand gives a decided sensation of cold. It is absolutely essential that great care should be taken in using gasoline or naptha, as they readily form explosive mixtures with air and the slightest spark may be enough to ignite the mixture if it happens to be of the right proportions. If a saturated mixture of naptha and air at the pressure of the atmosphere is exploded in a closed receptable a pressure of ninety pounds to the square inch can readily be attained. If the mixture contains more air than is necessary for combustion, the explosion will be less severe, and again, if the space is partly open or has but slight walls the pressure will be less. But in any case an explosion may be expected to give disastrous results. The writer has known a bad explosion to occur in an open boat house from naptha that had been spilled on the surface of the water.

It may consequently be considered that when gasoline is used in a confined engine room great care should be taken to make and keep all connections of the supply pipe absolutely tight, and that the first appearance of an odor of gasoline should

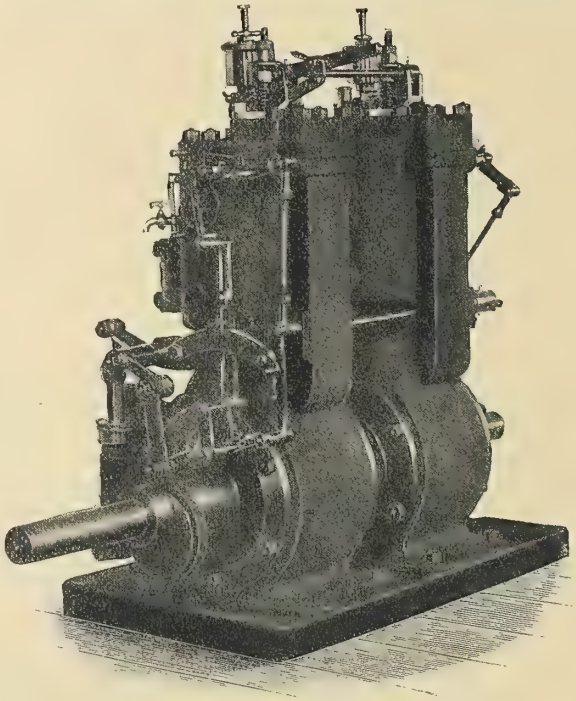


FIG. 16.—WOLVERINE REVERSING MOTOR.

call first for complete ventilation and extinction of fires and lights of all kinds, and second, for necessary repairs and adjustments. It is to be remembered, also, that it is the vapor and not the liquid that is dangerous; for example, an empty can is more dangerous than a full one. Open boats are, of course, little liable to danger of explosions, though the gasoline, if spilled, may take fire and burn.

Insurance companies in America and the government in England interfere with the storing and use of gasoline and naphtha, and so have checked their use in gas engines, especially for stationary purposes. Much attention has been given in England to the development of engines that can use refined or safe oils like kerosene. The difficulty in the use of such oils is that they cannot be completely vaporized by the application of heat alone. If a vessel containing kerosene is heated gently the fluid will begin to boil, and the vapor passing off may be caught in a condenser and liquefied. This distillate is lighter than the original oil, and the oil remaining in the vaporizing vessel is heavier. If the temperature is raised, more and heavier oil will pass off, and thus the oil may be separated by fractional distillation. There will, however, always be a remnant that will not vaporize but will finally break up if the temperature is raised high enough, giving a lighter oil and a tarry product. The last operation is a destructive distillation. It appears at first very

remarkable that kerosene, which is made from crude petroleum by fractional distillation, should not be vaporized completely when brought to the temperature at which it was made, but we are familiar with the effect of turpentine and other driers on paint and may conclude that the heavier products are carried along by the lighter. The only safe oil which will vaporize completely is Scotch shale oil, made by the destructive distillation of shale.

This will explain the failure of some of the earlier attempts to vaporize kerosene by passing it over red hot surfaces; in every case the vaporizer became clogged with soot and tarry matter and got out of order. The usual way of using kerosene or other safe oils is to spray them in hot air. Three ways have been used for this purpose: First, a cylinder is provided outside of the engine which can be heated by the exhaust of the engine. The air for the explosive mixture is drawn through this cylinder and is sprayed with kerosene from an atomizer. In order to keep the atomizing cylinder hot enough there must be an explosion for every two revolutions of the engine; that is, the engine must be regulated by throttling the supply of gas and air, and not by omitting an explosion. Second way is to have a bottle-shaped protuberance on the cylinder head which is not cooled by the water-jacket, and consequently gets very hot. The charge of oil is sprayed into this space, where it is partly volatilized by the hot walls and by the hot spent gas. The supply of fresh air is drawn in, compressed, and forced into this bottle-shaped space, where it is charged with oil and can be exploded. The third way is to draw part of the air supply through a heated vaporizer, where it can be charged with oil, and then mingled with fresh air and exploded. In all cases the heating of the air is prejudicial to economy, as has already been pointed out in the discussion of the theory of the gas engine. Again, oil engines are hampered by the fact that spontaneous combustion is likely to occur if the heated charge is compressed to a large degree. Consequently oil engines have a less mean-effective pressure and a less efficiency than gas engines or gasoline engines. This disadvantage is, however, turned to good account by makers of oil engines, who arrange that the compression shall be carried just far enough to cause explosion when desired, and so avoid the use of an igniter after the engine is started. In such case the engine cannot be governed by omitting explosions, for the engine will then be liable to stop.

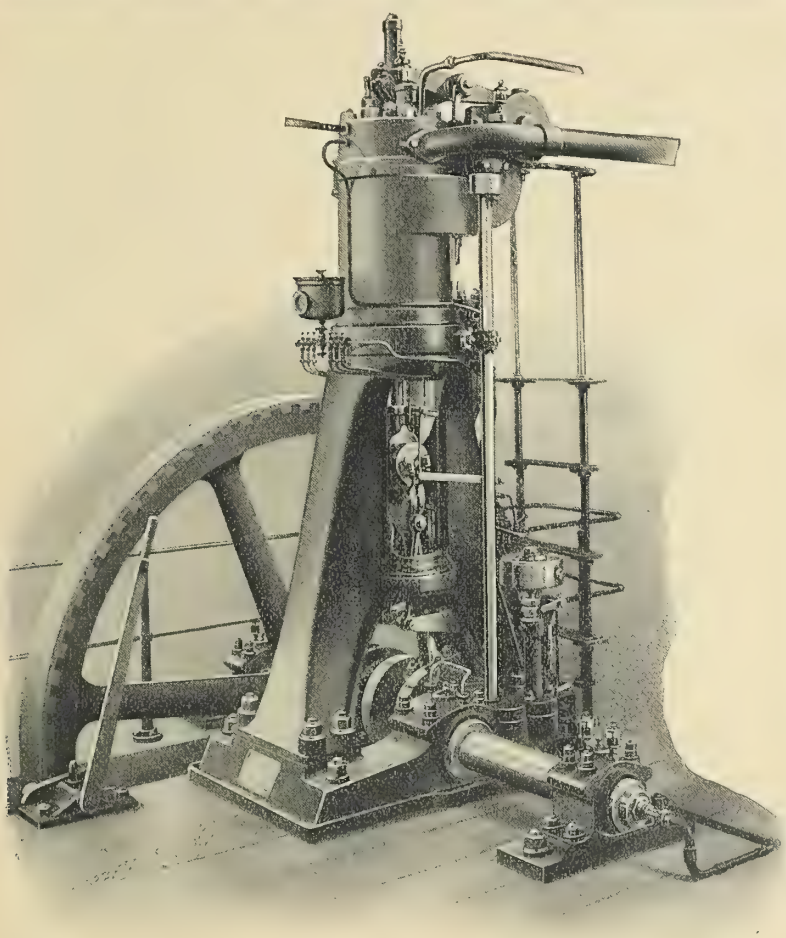


FIG. 17.—DIESEL STATIONARY OIL ENGINE.

All the engines thus far considered work on the Otto cycle and properly should have four strokes to complete the cycle; such as get an explosion for each revolution use a preliminary light compression and depend on the new charge to sweep out the spent gases. There is, however, an old form of engine which has apparently been abandoned which deserves a better fate. I mean the Brayton engine, which produced an indicator diagram much like that for a steam engine. As a gas engine, this engine drew in a supply of air and gas in a compression cylinder and compressed it into a reservoir at about sixty pounds above the atmosphere. The air and gas from the reservoir was allowed to flow into the working cylinder for about half the stroke of the piston, passing through a lamp on the way, where it burned and expanded in volume at constant pressure. As an oil engine air only was compressed, and passing through a combustion chamber burned with oil that was supplied by a small pump. This engine could use crude petroleum, or after it was started

could burn refined kerosine. It appears to have failed because the combustion was incomplete, which is not surprising considering the crude way in which the oil was supplied. The cycle is an old one, used by Ericsson for a hot-air engine, and appears to be worthy of further effort. If a clear, smokeless flame can be secured there seems no reason why the engine might not be a success as an oil engine; but the English makers of oil engines have succeeded in making lamps for heating ignition tubes which have a clear blue flame, and there appears to be no reason why such a flame cannot be obtained at higher pressure. The theoretical efficiency of such an engine compares favorably with that for an Otto engine, and if preheating of the air, as in present oil engines, can be avoided, there is no reason why a good economy cannot be obtained. Such an engine with three cylinders ought to reverse promptly, and could be controlled to a nicety by regulating the oil supply, as there is no necessity to form an explosive mixture.

Before closing this article reference should be made to the Diesel motor, which is now being introduced for stationary work. This engine, which is represented by Fig. 17, differs from the Otto engine mainly in that the clearance is so small and the compression so high that the air which is compressed in the cylinder is heated to about 1,000 deg. F., so that oil sprayed into it burns at once. So far this engine has used crude petroleum because it is cheap, but it can use any oil that can be sprayed in. It is claimed that an engine which indicated 26.6 horse power and delivered 19.2 horse power to the brake, consumed about half a pound of petroleum per horse power per hour.

The engine represented by Fig. 17 is solidly built to resist the high pressure (about 500 pounds per square inch), and is supplied with a heavy fly-wheel. The builders, however, make a three-cylinder engine which has a comparatively light fly-wheel. Marine engines with a number of cylinders (six or more) ought to run smoothly and reverse promptly.

Proposals will be immediately asked by the Bureau of Yards and Docks for the construction of the combined floating and graving steel dry dock, with shore connections and appurtenances, which is to be located at the naval reservation at Algiers, La. The date for closing will be October 31, 1898. Intending bidders can obtain particulars from Mordecai T. Endicott, Chief of the Bureau at Washington. The dock will measure 525 ft. long, 28 ft. draught over keel blocks, and 100 ft. wide in the clear. The dock will be proportioned for a battleship weighing 15,000 tons, 450 ft. long, and having two-thirds of her weight concentrated in the middle half of her length. The fluctuations of water level in the Mississippi are considerable, varying within a range of nearly 20 ft. The limit of cost of the entire works is $850,000.

DISCUSSION OF THE MERITS OF TORPEDO CRAFT AND SOME OF THE FEATURES OF DESIGN AND CONSTRUCTION.—I.

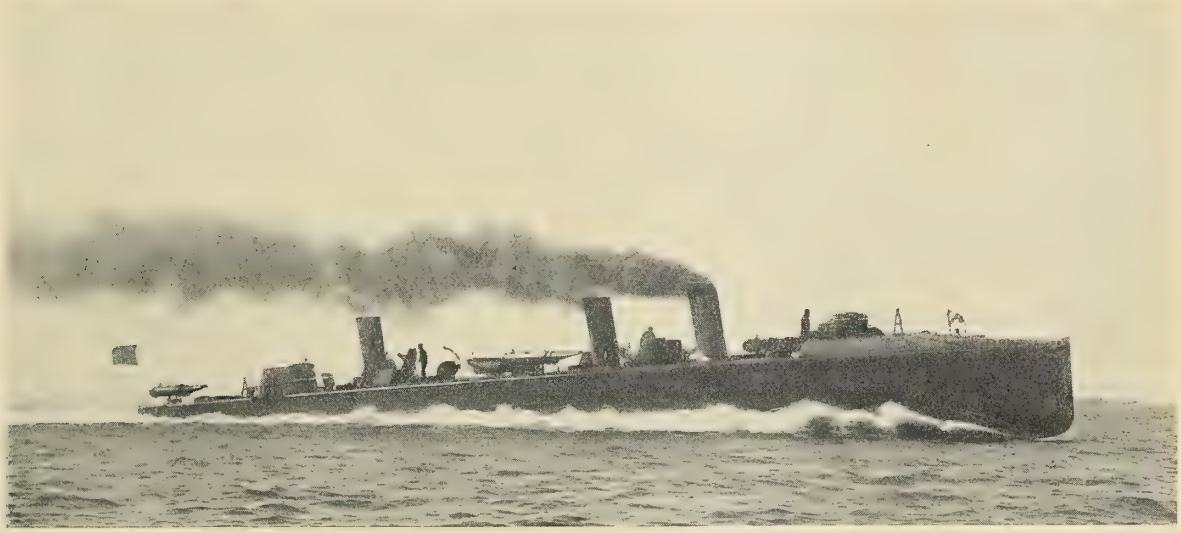
BY WILLIAM A. FAIRBURN.

Although the torpedo-boat is generally looked upon as rather an unknown quantity, yet there is nothing more promising of instructive and interesting development in modern naval warfare than this type of vessel. The Spanish-American war has unfortunately taught us nothing whatever about the efficiency of these high powered boats, and they must still be considered to a certain extent as an experiment. In this war the torpedo-boat has been conspicuous by its absence, and the two Spanish destroyers, "Furor" and "Pluton," at Santiago, could hardly have been expected to do the work they were designed to do, viz.: destroy torpedo-boats or act as torpedo-boats, when they were bottled up in Santiago harbor with a large fleet of powerful warships outside equipped with search lights, making a successful night attack almost as impossible as it would be in broad daylight.

USES OF TORPEDO CRAFT.

The torpedo-boat, like other types of vessels, such as the coast defense monitor, the gunboat for police duty, the scout type of cruiser, etc., is designed to fill a certain place in naval warfare, and if she fails to show up well when ordered to bombard land fortifications or attack heavier boats with her small rapid-fire guns, it does not mean that the type is a failure. The success of a torpedo boat, even in the work for which she has been designed, depends not only on the design and construction of the vessel, but these qualities must be multiplied by a "co-efficient of enthusiasm of the crew," for it is a fact that much of the boat's success or failure will be due to her complement. It is not the purpose of this article to discuss the question historically, but it may be well to state that since their first appearance in crude form thirty-five years ago, these boats have gone through a rapid and surprising transformation. They have developed from the open rowboat, with its spar torpedo, to the swift, high-powered vessel of the present day, carrying large automobile torpedoes. The torpedo-boat is often looked upon as a cowardly craft seeking the destruction of the enemy by insidious means, but "all is fair in war," and the torpedo-boat is designed to take advantage of the enemy's weakness along certain lines of defense. It requires pluck and genuine heroism in many cases for the torpedoist to accompany his missile to within a short distance of the enemy, and his chances of success are not by any means as great to-day as they were twenty years ago. With the present development of the automobile torpedo as a weapon of war 500 yards is the admitted effective range. Darkness, a mist or a fog, will greatly help the attacking torpedo-boat to get within this ef-

fective torpedo range, but as a means of defense the ship attacked will probably have, if one of a squadron at anchor, torpedo-boat destroyers, torpedo and picket boats cruising around and fixed beams of light illuminating zones across which the attacking boats must pass. The search light has been much improved of recent years, and naval men have much more faith in the powerful electric search light and picket boats than they have in booms and torpedo nets. If a squadron is cruising at night, all lights will probably be screened and the fighting ships will assume compact formation, the scouts and destroyers cruising around the fleet to prevent the enemy's torpedo-boats coming within torpedo range of the larger vessels. And yet from actual experiments made in the various navies of the world, it has been proved that the torpedo-boat can very often break through all these lines of defense, and with favorable weather conditions she has been known to often steam to within speaking distance of the ship she was supposed to attack, without being discovered.



Photographed and copyrighted by Frank A. Child, Newport, R. I.

AMERICAN TYPE TORPEDO-BOAT—U. S. S. PORTER BUILT BY HERRESHOFF'S.

CHARACTERISTICS OF DESIGN.

The torpedo-boat should be designed with the following characteristics in view: (1) The boat should be as small as possible, so that she will present a very small target for the enemy, and so that she will be as invisible as it is practicable to make her. (2) High speed is the greatest essential, and all other qualities should be considered but secondary to high speed and the ability to carry the torpedo armament. (3) All noise such as the thud of the engines and the clatter of the blowers should be carefully avoided. Flames shooting from the stacks will make discovery in a night attack certain, and even a large amount of energy expended in wave making may make water disturbances of so violent a nature that when combined with the noise of the machinery it would make discovery most probable. (4) In the design of a first-class torpedo-boat due consideration should be given not only to trial speed in smooth water but speed at sea. Her proportions should not be extreme, and the greater the speed in a seaway the more efficient the vessel will be. (5) Speed can only be obtained by sacrificing other qualities, therefore the weight of hull must be reduced to a minimum. High grade steel should be used and all material judiciously located. The vessel should not be designed with all the fittings of a cruiser and the accommodation of a yacht, but her furnishings should be simple and light and the equipment as light as possible. The complement of a torpedo-boat should be young, vigorous men, capable of roughing it. (6) Economy of coal is an important item, as the amount of fuel necessary to give a required radius of action if large will greatly decrease the vessel's speed. (7) The armament should consist of one or more torpedo guns, according to the size of the boat, located to give the best all round efficiency, and a small battery of 1 to 3 pounder rapid-fire guns should be fitted to repel boarders and engage vessels of her own type. (8) These boats should have good maneuvering qualities, and the smaller type of coast defence torpedo-boats should draw as little water as is practicable, as they must depend to some extent for their safety upon their ability to elude chasing torpedo-boats and destroyers by running into shallow water.

CLASSIFICATION OF TORPEDO CRAFT.

Torpedo-boats can be divided into "three classes," viz.: The Sea-Going Torpedo-Boat, or first-class boat; the Coast Defence, or second-class torpedo-boat, and the Vedette, or third-class boat, which is carried on the deck of a first-

class fighting ship. The first-class or Sea-Going boat should have a length of not less than 140 ft. and a minimum displacement of 120 tons. The second class or Coast Defence boat will probably vary from 80 ft. in length and 30 tons displacement as a minimum to the size of the first-class boat. The third class must be light and small enough to be hoisted on board a battleship, usually from 10 to 18 tons displacement. Although there is a minimum to the question of speed, there is no maximum, and it is usually a case of get all the power and speed you can on any boat of stated size, carrving the stipulated armament and trial load. The speed obtained will show the skill of the builders, for the highest speed can only be obtained with an excellent design and first-class workmanship. A 120-ton boat of the first class should steam at least 25 knots. A 30-ton second-class boat should have a speed of at least 20 knots, and 17 or 18 knots is generally considered good speed for a Vedette or third-class boat. There is, however, another type of torpedo craft which has of late been very popular with the naval authorities of the world, viz.: the torpedo-boat destroyer. The British a number of years ago attempted to reply to the large number of French torpedo-boats by building torpedo catchers or torpedo gunboats. These vessels, with a speed of 18 to 21 knots and a displacement of from 550 to 810 tons, although useful additions to a fleet, did not prove successful as torpedo catchers, the reason being that many of the torpedo-boats afloat at that time had a speed of 26 and 27 knots. Profiting by experience, the British Admiralty in 1893 decided to build a new type of torpedo catcher, which proved to be merely an enlarged torpedo-boat of high speed and great sea-keeping power, with a powerful rapid-firing armament and torpedo guns. The first torpedo-boat destroyers proved very successful, and within the past few years the British have built about 100 of these useful vessels, the speed rising from 26 and 27 knots to 30 knots, and even 32 and 33 knots is spoken of now by two British firms. The displacement of these boats varies from 220 and 240 tons for the 27-knot boats to 275 and 300 for the 30-knot boats. The "Destroyer," as its name signifies, is designed to destroy all types of existing torpedo-boats, and it is desirable that the following qualities should be carefully considered in the design of this type of vessel: (1) High speed at sea is absolutely essential, and therefore the vessel must be much larger than the torpedo-boat, and their proportions should be such as to give great sea-keeping ability. It is essential that the speed should be greater than that of all existing torpedo-boats; but it is well to here note that whereas a moderate sea will reduce the speed of a 140-ton torpedo-boat from 26 to 22 knots, the same conditions will probably reduce the speed of a 300-ton destroyer only about 2 knots. (2) A destroyer should have a powerful battery of rapid-firing guns, capable of destroying any type of torpedo-boat. A battery of 6-pdr. rapid-firing guns is sufficient for this purpose, and the modern practice is to fit such a battery; also a 12 or 14-pdr. R. F. G., which is located on the forward conning tower; some of the larger destroyers carry two of these larger guns. (3) A large radius of action is especially desirable so as to enable these vessels to operate at a good distance from the base of supplies. Economy of fuel is, as in the case of torpedo-boats, a very important item. (4) It is desirable to design destroyers so that they can operate as torpedo-boats whenever the opportunity presents itself; therefore the boats should be as small as possible consistent with sea-keeping power, and almost all the requirements for the successful torpedo-boat apply also to the destroyer.

U. S. BOATS UNDER CONSTRUCTION.

There are now built or building seventeen torpedo-boats and four destroyers for the United States Navy, and in a few days contracts will be awarded for twelve more torpedo-boats and sixteen destroyers. Of the seventeen torpedo-boats now built or building, nine are of the first class, with a displacement varying from 120 to 184 tons, and with a speed of from 24 to 30 1-2 knots. The remaining eight torpedo-boats are of the second class, their displacement varying from 47 to 110 tons and their speed from 20 to 22 1-2 knots. The four destroyers now building are from 235 to 340 tons displacement, and all are designed for 30-knot speed. The new torpedo-boats about to be contracted for are of 150 to 170 tons displacement and probably 26 to 29 knots speed, whilst the proposed destroyers are of 400 to 435 tons displacement and 28 to 30 knots designed speed.

TYPE OF BOAT NEEDED BY U. S.

"What type of torpedo craft do we most need?" is a question that is receiving considerable attention to-day. The writer will answer this question by asking, in the first place, "Why build destroyers?" No foreign nation powerful enough to wage war against us is situated so that it could despatch a torpedo-boat flotilla to our shores. The first-class torpedo-boat is too frail and too small to attempt a great ocean journey, and she requires so much continual attention that it would be unwise to burden a fleet of ocean-going fighting ships with these vessels. The British have good reason to dread the torpedo-boat, and build destroyers to destroy them, for each of the other powerful European nations can send torpedo flotillas against her that will never be far from their base of supplies and repair depots. But with the United States the conditions are very different, and the only torpedo vessels that will ever harass our shores are the larger destroyers. These boats, being larger and more seaworthy than the torpedo-boat, have also a very much greater endurance and they are ca-

pable of keeping their position in a fleet of sea-going fighting ships on the high seas. Then, "Why do we need destroyers when there are no torpedo-boats around our shores to destroy?" Unless the foreign policy of our Government has changed, unless our success in the Spanish-American war makes our future policy aggressive, instead of "Defence and not Defiance," as our motto has always been up to this time, we do not need destroyers. We certainly do need torpedo-boats, and we need large numbers of them both of the first and second class, for our coast line on both the Atlantic and Pacific oceans is very extensive, and the torpedo-boat seems to be an admirable means of defence. It has been stated that we need to build destroyers as a reply to the destroyers that a foe may send against us. None of our destroyers now building is as powerful as the best European vessels of this class. Our policy should be to design and build vessels superior to any that an enemy might send against us, and we should reply to the European destroyer by building a "Destroyer of Destroyers." Such a vessel would require a higher sea speed than any destroyer at present afloat, an armament powerful enough to sink any torpedo vessel, armored protection sufficient to resist the fire of a destroyer, and, lastly, great endurance. A large destroyer of 450 tons trial displacement could be designed to fulfil all of these conditions, the protection consisting of 2-inch nickel steel and the radius of action about 6,000 miles. The armament could consist of two 4-inch and six 6-pdr. R. F. G. and one torpedo gun, which is greatly superior to that of any destroyer built or building. The 400 to 435-ton destroyers for which contracts will soon be awarded are not as powerful as the latest European destroyers, but such a vessel as here proposed, a "Destroyer of Destroyers," could be built for very little more money and would be capable of destroying any vessel of the torpedo-boat or destroyer types afloat. The writer therefore strongly advocates the construction of torpedo-boats and armored-destroyers, and unless we are going to meddle with European politics and commerce an aggressive foreign policy and a tour of conquest, we do not require the ordinary destroyer. Such vessels could but act as torpedo-boats, and their cost would be twice as much, for the cost of torpedo vessels varies almost directly as their displacement.

CONCERNING CONVERTED YACHTS.

It is amusing to-day to hear misinformed persons denounce the torpedo-boat and praise the type of auxiliary war vessel—the converted yacht—which has been popularly termed in our daily newspapers the "torpedo-boat destroyer." The splendid fighting of the "Gloucester" (formerly steam yacht Corsair) at Santiago is undoubtedly responsible for much of this talk. Why not condemn likewise the armored cruisers? for truly all the Spanish vessels failed alike to show up well when brought face to face with a powerful enemy, consisting of the finest fighting machines afloat and a complement of a decidedly superior quality. The writer has seen much of the European destroyers and the personnel of these vessels, and when manned by men of the Anglo-Saxon type they will not only keep the destroyer of the converted yacht type guessing—owing to their speed being just twice as great—but their armament is much more powerful than that of the converted yacht. Steam yachts will undoubtedly always do good work in the auxiliary navy as picket- or despatch-boats, but they must never be considered as in the same class with torpedo-boat destroyers.

DIFFICULTIES OF TORPEDO-BOAT DESIGN.

A practical ship-builder, with little or no knowledge of the science of naval architecture, may successfully build coasting schooners or passenger steamboats, but when it comes to torpedo-boat design, practical experience and guesswork amount to nothing, and theory, science and art must take their place. The practical construction of the torpedo-boat is as much different from that of the merchant steamer as the mechanism of a watch is from that of a tower clock. No shipbuilding firm will ever make a success of torpedo-boat construction which does not appreciate the delicacy of the work. Big ship methods must be discarded, the "guess of about so much" omitted, and all parts of the vessel and her machinery carefully proportioned to withstand a certain stress with a certain factor of safety. A special department for the construction of torpedo-boats is a most desirable arrangement when large shipbuilding firms contract for this type of vessels, and a first-class designer and theoretical man, together with a first-class practical man experienced in this class of work, are essential if the establishment is to make a success of the construction of torpedo craft. Shipbuilding firms that appreciate the greatness of the undertaking, the delicacy of the work, the difficulty and necessity of obtaining a good design, and the many obstacles that will have to be overcome before they can obtain the required speed, when they make their estimate of cost will probably make a success of this class of work. First-class technical men can be obtained to take charge of the work if the inducements made are great enough. The difficulties of torpedo-boat design are alike in both hull and machinery. The hull must be designed as light and as rigid as possible consistent with strength, and of such shape as to be easily propelled through the water the required speed. The machinery must be capable of developing maximum power with the least possible weight, and it must also be durable, compact, accessible and economical.

HINTS ON DESIGNING THE MODEL.

Let us first consider the design of the model. The lines of the vessel must be adapted to the

designed high rate of speed, and they must be capable of carrying the machinery and forming a suitable platform for the torpedo guns. It is quite common in torpedo-boats designs to see the boiler located in the design and the vessel's lines made to conform to this "tight section." Great natural strength should be considered when getting out a set of lines, and the nearer the vessel approaches to a tube in shape the more natural strength she will possess. The weight of hull and the strength of the vessel should be considered when the lines are being made, for it is possible to get a stronger hull of less propulsive efficiency which might show up better in the aggregate than an easier lined vessel which requires heavier scantlings to obtain the same strength. The transverse sections should be a fair curve throughout, with no straight lines or quick turns. It is usually advantageous to locate the greater beam above the load water line, with a rapid tumble home between this point and the deck. The former point is to increase the vessel's stability, and is based on the experience of the French government with torpedo-boats, whilst the latter feature is to save weight and increase natural strength. When a torpedo-boat reaches a speed given approximately by the formula $9\sqrt[6]{\text{Disp.}}$ the boat will commence to rise out of water, and the displacement will gradually be diminished as the speed increases. If the stern transverse sections are V-shaped the boat will squat aft as the bow rises. The only means of avoiding this disagreeable squat, which is accompanied by a considerable loss of stability, is to use a broad, flat stern. Even with the best broad stern obtainable the change of trim will be considerable when the boat gets up to her maximum speed, but such a stern will not sink beyond the knuckle; on the contrary, the bow will steadily rise, and the total displacement will diminish after reaching the rising speed, as already stated. The following figures will prove interesting, as they give the speed at which torpedo-boats and destroyers will commence to rise out of water:

Displacement.	Rising Speed.
25	15.4 Knots
50	17.3 "
100	19.4 "
150	20.7 "
200	21.8 "
300	23.3 "
400	24.4 "
500	25.4 "

The great change of trim noticeable on torpedo-boats when running at high speed is not however caused entirely by the bow rising and thus decreasing the displacement; the boat runs along on the back of a transverse wave having a speed equal to her own, so that her change of trim in respect to the horizon is considerable more than that shown by the water against the side of the boat. The phenomenon of change of trim brings into prominence an essential feature of torpedo-boat design, viz.: the matter of keeping the forefoot very deep and almost square in order to avoid shortening the effective water line length when running at high speed. It will be readily seen that any part of the boat forward of the speed water line is so much useless appendage, and when economy of weight is such an item as in torpedo-boats, overhanging bows and such like appendages should be avoided. The spoon and semi-spoon bow—in longitudinal elevation—is being adapted somewhat now on the latest American designs, but the writer fails to see why the weight of such a stem should be added and why the appearance of a boat should be spoiled by such a forward ending. A torpedo-boat with a plumb stem and bow sections flaring above the load water line is an unusually dry boat forward in a sea way, and French builders do not even consider a turtle back forward desirable. Many of the pet theories of some of our torpedo-boat designers would, I think, be dashed to the ground if they had actual sea experience on a correctly modeled torpedo-boat. The standard ratio of length to beam on the water line of torpedo-boats is 10 to 1, but it varies from about 9 to 11 for first-class sea-going boats. The beam when stated is often given as the maximum molded beam, and the water line beam on some boats is as much as 9 in. less than this dimension. The smaller the boat the wider she must be so as to obtain the necessary stability. The broad flat stern increases the initial stability considerably, for besides raising the center of buoyancy it greatly increases the area and moment of inertia of the water plane, and therefore raises the metacenter, whereas the center of gravity of the hull is raised but little. The deeper the boat, the more natural strength she will have, the more freeboard she will possess, and the more room there will be in her interior for the machinery and quarters.

Description of Auxiliary Naval Vessels.

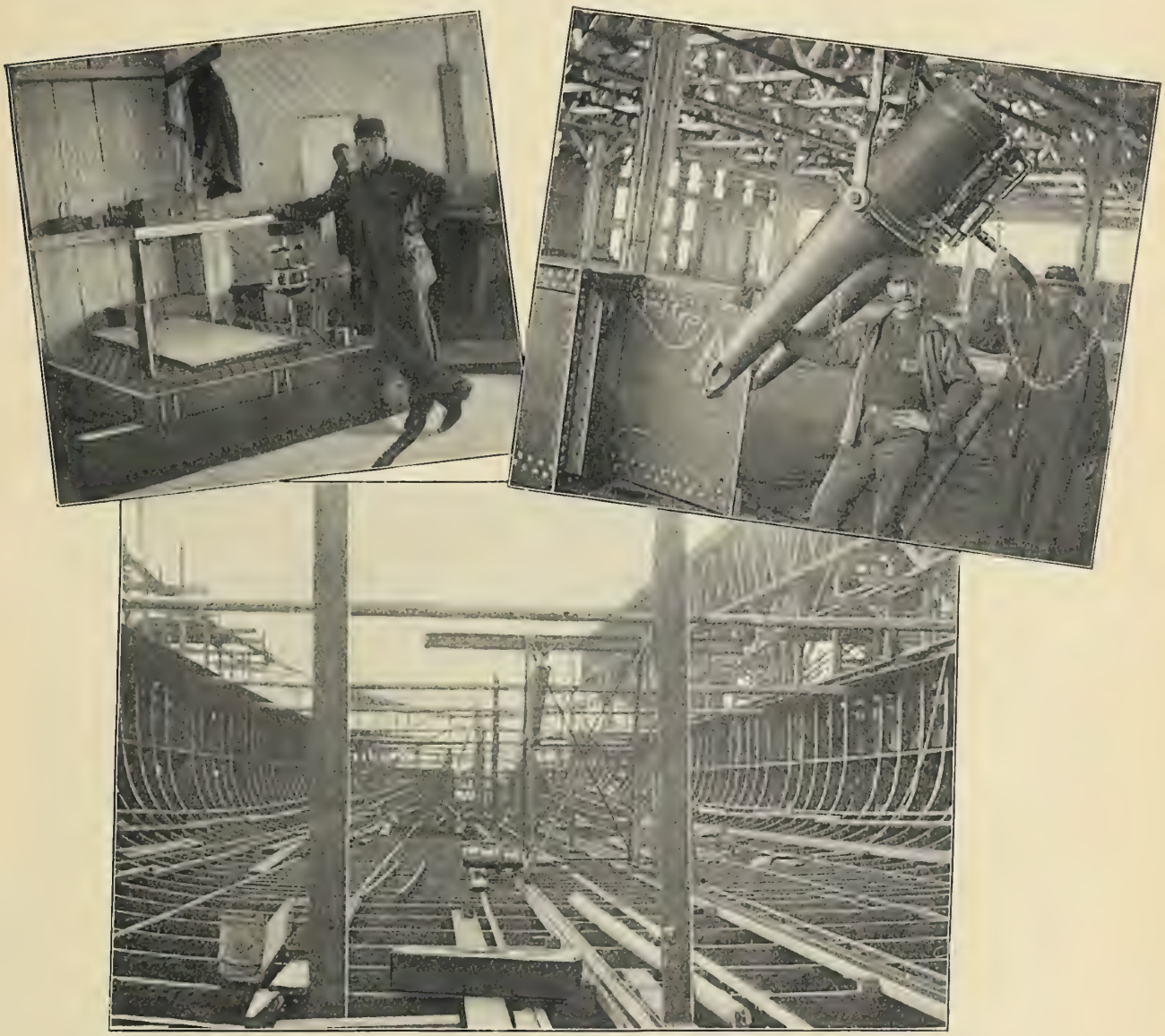
Since the publication of our fourth list (in August) of vessels secured by the Navy Department for use as auxiliary naval vessels, the war has been brought to a close by peace negotiations. Already preparations are being made to put out of commission several naval vessels, and to sell or otherwise dispose of auxiliary vessels. It is probable that some vessels of the collier type will be retained by the Department. It will be some time, however, before any final disposition is made of all the vessels added to the Navy since the beginning of the Spanish-American war. The lists we have published are brought up to date by the addition of one vessel, of which the following are the particulars: Old name and date of build, Luciline, 1893; old class, freight steamer; length, 332 ft.; beam, 42 ft. 2 in.; depth, 26 ft. 5 in.; tonnage, 3,319 gross; where built, Stockton, England; former owner, A. Suart; new class, water boat and tank steamer; new name, Arethusa.

EXPERIENCES WITH COMPRESSED AIR IN SHIP-BUILDING AND SHIP-YARD WORK.

BY WILLIAM BURLINGHAM.

Of late years great advances have been made in the use of compressed air as a motive power for small tools, and it is already considered on an equality, and for many operations, superior to steam, electricity or hydraulic power.

Practically all the large railroad and ship-building plants in the country have adopted this form of power in a greater or less degree. It is possible to convey it from point to point with great facility and practically no drop in the pressure, though the pipes may be very long: For example, at the Jeddo Tunnel, in Pennsylvania, air at 60 lbs. pressure was carried 10,860 feet, and the guages at both ends of the pipe showed no difference in pressure. There are many other instances of this kind, where it would be practically impossible to convey steam, and consequently a small boiler with fireman would be necessary at the scene of operations. Other advantages are that it lends itself for use in all kinds of holes and corners. There is very little, if any, danger from frost, if the pipes are properly laid, protected and drained. There is no chance of short circuits or unforeseen shocks; no solenoids or delicate armatures to get out of order and no heavy mass of iron and copper to transport in the shape of an electrical motor, for the purpose, for instance, of drilling a 3-4 in. hole. There are no leaky joints as in hydraulic motors, and no trouble from condensation and lack of positive movement as in steam.



PNEUMATIC DRILL AND PORTABLE RIVETERS, IN SHIPYARD WORK.

Its economy is equal, if not superior, to any of the existing prime movers, if used with judgment and due regard for its capabilities and for the

right tools; that is, for those various small tools that are located at a considerable distance from the source of power, operating in many different places in a short interval of time.

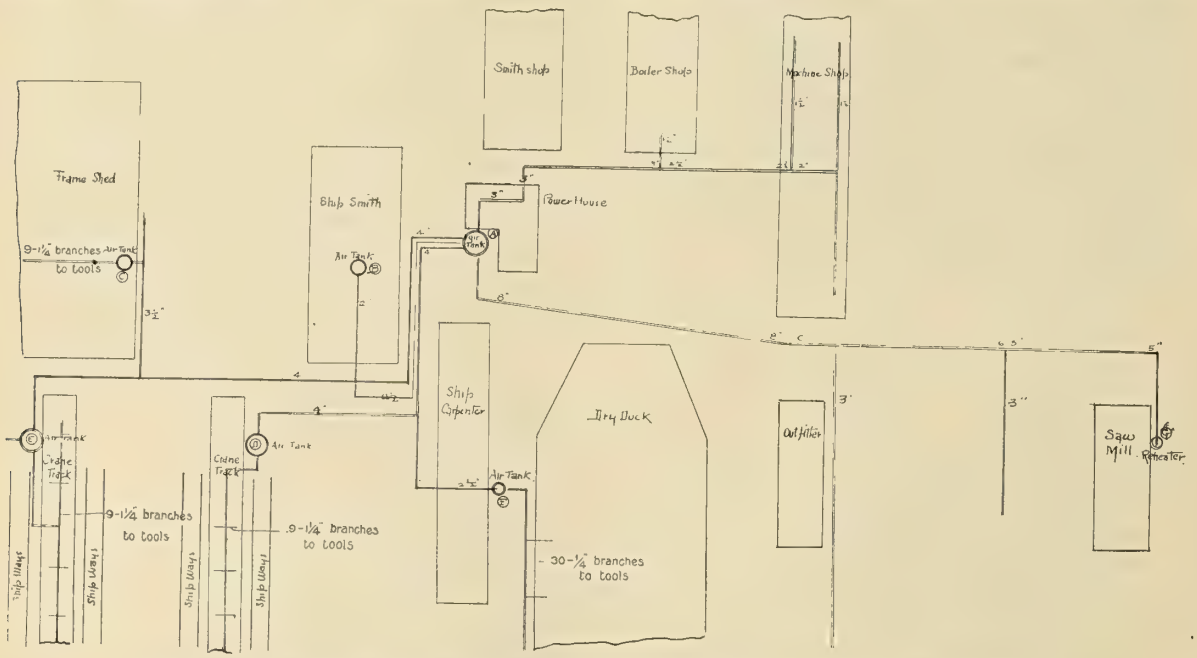
It is the general opinion that air, water and steam are pre-eminently suited for pressure operations or where blows are to be delivered, and electricity for rotary motion. Experience, however, has taught that for hand tools, both rotary and reciprocating, the air engine has most advantages in establishments where light and easily handled tools are a necessity.

The fact that an ordinary mechanic can repair and adjust air motors, while it requires an expert electrician to repair an electric motor, would seem to make it preferable to use the former method, as ordinary mechanics are more numerous in a shipyard than expert electricians.

Compressed air should be used and not abused. Small leaks are very prevalent in the piping, valves and loose couplings, and worn out motors often consume an excessive quantity of air. These are very small matters in themselves, but taken collectively in a large plant, have a very depressing effect upon the coal pile and an elevating one on the expense account. Treat the air plant with the same care that is manifested in the insulation of electric wires or lagging of steam pipes and there will be less grumbling heard concerning the wastefulness of the system. A committee of the Master Mechanics of the principal railroads of this country reported at the last meeting, 1897, that the use of compressed air, with suitable apparatus, gave an average economy of from 25 to 50 per cent. over the ordinary former practice, in their shops, on the following work:

Tapping out stay bolt holes, reaming and drilling holes, chipping and caulking, removing tires, beading flues, air hoists, vertical and horizontal car jacks, tinware presses, shears erected outside shop for shearing off test coupons, tank riveters, shears at scrap pile, shears for light sheet iron work, small Pelton wheels for operating emery wheels, blast for blacksmith forges, applied to mixing paint in large quantities by putting a pipe in bottom of mixing barrel, used in all kinds of motors for boring cylinders and facing valves, cleaning cushions inside and out of cars, blowing out cylinders before inserting packing, rolling flues, swedging flues, testing brakes and numberless other minor purposes.

The following particulars were given of a shop turning out sixty engines per year, viz: One compresser with 15-in. steam, 14-in. air cylinders and 18-in. common stroke, five elevators, one hoist for driving wheel lathe, six hoists for lathes and planers, two Brotherhood engines, three motors, one sand elevator, one fire kindler and one flue cleaner. The cost of this compressor, including foundations and pipe connections, was $1,260.50. Pipe lines, hose, valves, reservoirs, motors, hoists, elevators, cost $1,189.50. A total of $2,450.

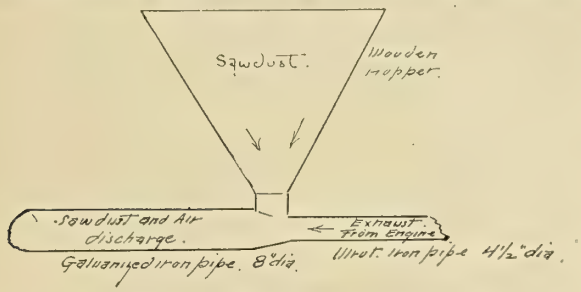


SYSTEM OF COMPRESSED AIR PIPING AT THE NEWPORT NEWS, VA , SHIPYARD.

On a test run of eight hours it required 313 lbs. of coal per hour or 2,508 lbs. for the run. Pressure was raised from zero to 120 lbs. in 5 minutes 40 seconds. The compressor made 858 revolutions and compressed 2,681.6 cu. ft. of free air to 193.9 cu. ft. of air at 120 lbs. It required with this compressor 20.4 lbs. coal to compress 1,000 cu. ft. of free air to 120 lbs., equaling 60 per cent of its theoretical capacity. The packing of this engine had not been overhauled for eighteen

months, thus accounting for some of the deficiency.

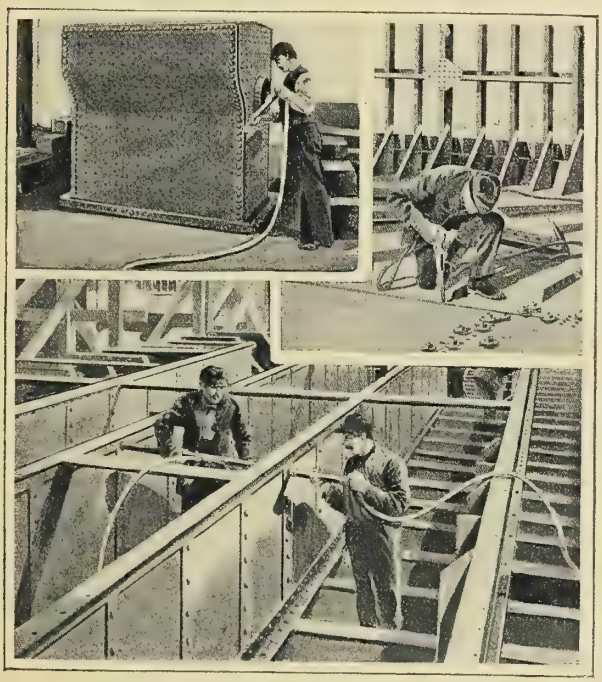
It is during the building of a ship that the advantages of these power tools are best exemplified. A hull is full of odd corners and nearly inaccessible nooks that must be as well riveted and caulked as the most accessible part of the



PNEUMATIC SAWDUST EJECTOR.

vessel; perhaps better, as it is more difficult to overhaul and examine these places.

It is not so long ago that the best yards in the country depended upon the ratchet drill and hand riveting, the work having to be done in such inconvenient places and uncomfortable attitudes upon the part of the workmen as to preclude the possibility of a first-class job. Now from the driving of the first rivet in the keel to the launch of the vessel the continuous clatter of air riveters, caulking tools and the whirring of rotary



CHIPPING, CAULKING AND RIVETING WITH PNEUMATIC TOOLS.

drills are sure indications of rapid progress toward completion.

Probably one of the largest and best equipped air plants for the use of small tools is located at the works of the Newport News Shipbuilding and Dry Dock Co. Comparatively new, this air plant now furnishes the power for the majority of the tools used on the outside work of the various naval and merchant vessels building there, to the exclusion, almost, of steam and electricity.

The original plant consisted of a small Rand compressor and a few tools; then a couple of Pedrick and Ayer compressors and more tools were added. Now, hardly more than three years since the starting of the initial plant, there are in operation three Ingersoll & Sergeant compressors, viz:

One class G, half-duplex-slide-valve compressor, with 20-in. steam and 20-in. air cylinders and 24-in. stroke, run at 94 revolutions per minute, with a capacity of 1,600 cu. ft. of free air. The air discharges through a 5-in. pipe at 100 lbs. pressure.

One class G duplex compressor with 20-in. steam cylinder, 20 1-4-in. high-pressure air cylinder and 32 1-4-in. low-pressure air cylinder and 24-in. common stroke. This engine has a receiver inter-cooler 36-in. dia. by 9 ft. 6 in. long, and discharges at 100 lbs. pressure.

One class G duplex compressor, with 20-in. dia. steam and 20 1-4-in. dia. air cylinders and 24-in. common stroke, with a capacity of 3,200 cu. ft. of free air per minute and 100 lbs. pressure at discharge.

These compressors are all made with the piston inlet air cylinders, are water jacketed and are furnished with a governor automatic pressure regulator. The compressed air is discharged into a storage tank common to all at about 90 lbs. pressure.

These storage tanks are a necessity and should be of such size as to enable the engines, after once filling them, to run at a moderate speed during working hours.

The tanks are usually provided with pop safety valves, ample drainage, and from the first tank a small pipe is led back to the automatic regulator on the engine. From this main tank the air is carried by mains to smaller storage tanks located at different points in the yard, nearest the centres of work.

By constructing the storage tanks with a baffle plate down the center, the air entering at the top impinges upon the plate, delivering the entrained water into the botton of the tank, from whence it is drained at intervals. The air then passes under the baffle plate and out again at the top of the tank. The air pipes should always enter and leave the storage tanks at the top.

The drawing on page 16 is a plan of the yard piping. The main air pipe is about 1,500 ft. long, of cast iron, with leaded joints, 8-in. inside dia. and reduced at intervals to 6 in. and then to 5 in. At the end it enters a reheater similar to a surface condenser about 27 in. dia. and 6 ft. long, with wrought iron tubes 1 1-4 in. dia., and is there heated by the exhaust steam from one of the shop engines. This reheated air is employed to run a

regular type Atlas horizontal steam engine that furnishes power for a large band sawmill. The exhaust air from this engine is employed to force the sawdust from the mill as it accumulates. The device is shown on page 17. The air pipe to the engine is 3 1-2 in. dia. and the exhaust 4 1-2 in. dia. The reheater also supplies air to a small motor for a saw grinding machine.

At any point in this system the pressure guage will register the same as at the main tank, and even under the most unfavorable circumstances there is but little appreciable drop. There are four other mains leading from the storage tank, two 4 in., one 3 in. and one 2 1-2 in., all wrought iron pipe with screwed joints. All pipes used in connection with this plant are buried in trenches below the frost line.

The 2 1-2 in. main has supplied power sufficient for twenty-eight No. 2 Boyer hammers and four drills, but this was the full working limit of the pipe; about two-thirds this number would be a preferable load. The hammer supply nozzle is 1-4 in. and the drills 3-8 in. pipe taps. The yard has used nearly every type of pneumatic machine that is manufactured and even now have many different types in use.

Some of the different operations performed by the tools are shown in the group picture on page 17. In everyday use many of the tools work more satisfactorily than others, in the matters of economy, in the use of air, freedom from breakdown and the not least important absence of vibration. Indeed, some tools which work satisfactorily in the first two named respects, are very severe on the workmen. They are all liable to break in one part or another, but the manufacturers are constantly improving and strengthening the weak parts as they are taught by experience.

The pneumatic riveters are a little larger than the hammers or caulkers, with a head that fits the head of the rivet. The work of driving the rivet is done by a large number of comparatively light blows instead of a single squeeze as in a hydraulic machine. This permits of the use of a very light frame for holding the riveter. The latest type is that patented by the Detroit Dry Dock Company, and is made of 2 1-2 in. W. I. gas pipe, bent to a U shape, with a gap of about 60 in. This frame enables the workman to reach rivets that are absolutely unapproachable otherwise than by hand riveting. Nearly all makes of pneumatic drills are practical; some are more powerful than others for the same weight. Their great difference is in their economy. All are extremely liable to breakage in some minor points, and a small repair shop is a necessity where many pneumatic tools are used. The drills are made in three types, the movable cylinder, the movable piston and the rotary, similar to the rotary pump; these last are great consumers of air and are not to be recommended where economy is a feature. The movable cylinder type, at the present date, seems to be the most economical and is at the repair shop the least often, considering the amount of work done by it.

It is necessary that care be taken to keep these machines clean, well oiled and in good working order. Proper lubrication is an essential requirement, both as to quality of oil and frequency in applying it. The best winter strained lard oil or valvoline sewing machine oil are recommended. Should it become necessary to clean the machine, admit kerosene and turn slowly while the grease is dissolving, and when all is dissolved admit air through the throttle. Thoroughly lubricate again before using.

As these machines are made interchangeable, the parts most liable to break should be duplicated in store. These cost but little and afford a most excellent insurance against stoppage from breakdowns.

For work in the frame sheds, on bulkheads and reverse frames the Caskey or single squeeze pneumatic riveter is used. This is a very good and efficient tool; it is usually slung from a jib crane with a long jib, by a chain twist, and thus commands a large area.

The larger illustration on page 15 shows this riveter at work on the double bottom of a battleship. A track was laid down the center of the inner bottom. This was for the crane carriage. The riveter, as shown, is held by a neumatic hoist. This was found to be a poor arrangement, as the elasticity of the air in the pneumatic hoist prevented a rapid setting of the hammer on the rivet. A Weston chain hoist was afterward used with success.

For general work about the yard a see-saw arrangement was devised, consisting of a beam, supporting the riveter at one end, with a counter balance at the other. The beam rested on an A frame carriage. This allowed a great latitude of movement and was eminently successful. It is shown in the upper right hand cut in the group on page 15.

The amount of work done by these pneumatic machines is greatly dependent upon the workman, and the men must be picked by actual trial to secure the best results.

AMERICAN STEEL FOR BRITISH SHIPYARDS.

Export orders for steel plate for the Clyde and for Belfast, Ireland, are now being filled in this country. The Illinois Steel Company has closed a contract with Harland & Wolff, the great Belfast, Ireland, shipbuilding firm, for a consignment of high grade open hearth material. Through the courtesy of the company we are enabled to here present a view of the plate mill, showing the ingot runway in the foreground and the mill tables and rolls further away. In this fine mill manual labor is dispensed with as much as possible in the actual operations of steel making. Men are only employed for manipulating the

steam, hydraulic and electrical apparatus, which replaces the old-time methods of steel making.

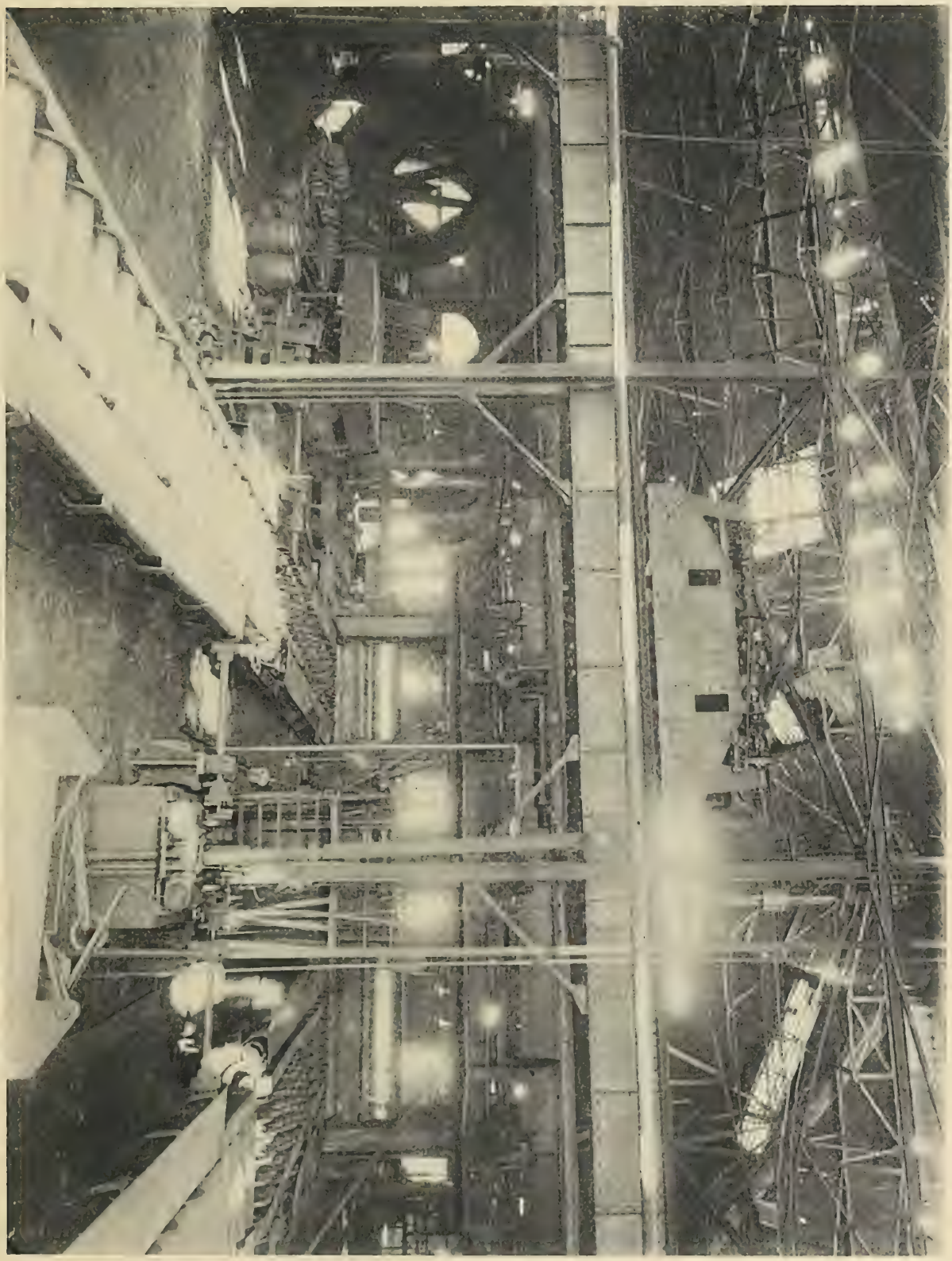


PLATE MILL IN THE OPEN-HEARTH STEEL DEPARTMENT OF THE ILLINOIS STEEL CO. AT SOUTH CHICAGO, ILL.

As showing the high quality of steel now turned out on this side of the Atlantic, we have secured photographs and particulars of test pieces cut from orders recently filled by the Illinois Steel Company at its South Chicago plant. Both the plate and bar steel shown were rolled from open hearth steel for two large Scotch boilers for the Lake steamer W. R. Linn, built by the

Chicago Shipbuilding Company, at South Chicago. The boilers were constructed at the establishment of John Mohr & Sons, at South Chicago.

The cold bend test of the shell plate was made with a test piece 1 15-32 thick, of open hearth steel, made to the U. S. marine specifications, as follows:

Elongation .....25 per cent in lengths of 6 in.
Reduction of area.....Not less than 40 per cent.
Tensile strength.....Not less than 60,000 lbs. per sq. in.
Phosphorous .....Not more than .06 per cent.
Sulphur ..... .04 per cent.

The actual physical and chemical results of the piece of plate were as follows:

Tensile strength per sq. in .....60,530 lbs.
Elongation in 6 in.....27.33 per cent.
Reduction of area .....49.94 per cent.
Chemical Analysis:
Carbon ..... .29 per cent.
Sulphur ..... .03 per cent.
Phosphorous ..... .033 per cent.
Manganese ..... .37 per cent.

The other test was also a cold bend test of open hearth steel, 2 5-8 in. dia., for stay bolts for the boilers.

This steel was made to the following specifications:

Tensile strength.....50,000 to 58,000 lbs. per sq. in.
Elongation .....35 per cent in 2 in.
Reduction of area.....50 per cent in test piece 5-8 in. dia. and 2 in. between fillets.

Cold bend test of full size bar to stand bending round a curve, the inner radius of which is equal to one and one-half times the diameter of the finished bar, in accordance with the rules and regulations of the Board of Supervisors of Steam Vessels of the U. S. Government.

Sectional area of billet from which the rod is to be rolled shall not be less than four times that of the finished bar at the rolls.

Test piece to be machined out of the finished bar. The center of the test piece to be midway between the center and circumference of the finished bar.

Phosphorus and sulphur, not over .03 per cent.

Manganese not less than .30 nor over .50 per cent.

The test of the steel produced for this order gave these results.

Physical Results of Machined Test Piece:
Tensile strength .....54,270 lbs. per sq. in.
Reduction of area .....51.49 per cent.
Elongation .....35.50 per cent in 2 in.
Chemical Analysis:
Carbon ..... .20 per cent.
Sulphur ..... .027 per cent.
Phosphorus ..... .011 per cent.
Manganese ..... .43 per cent.

The radius of the bend shown in the engraving is 1-2 in., or a much closer bend than that required by the government test.

The boilers for which this steel was rolled were designed for a pressure of 200 lbs. per sq. in. The dimensions were: Dia., 14 ft. 8 in.; length, 11 ft. 6 in., each having three Morison furnaces 44 in. dia.

The open-hearth steel department of the Illinois Steel Co., at South Chicago, was put in operation in February, 1895. The building containing the furnaces and casting pits is of brick and steel construction, 100 ft. wide and 651 ft. long.

The furnaces, ten in number, are placed along the length of the building, giving half of the width of the building for casting and for handling ingots, molds and slag. Back of the furnaces is a charging floor twelve feet above the yard level. The charging floor and furnaces are spanned by a 20-ton electric traveling crane. Over the front of the furnaces and the rest of the building, running parallel to its length, are one 40-ton, two 30-ton and two 75-ton electric traveling cranes. There are four open-hearth steel furnaces of 25 to 28 tons capacity for each heat. These are of the Wellman stationary type of the Siemens regenerative furnace, and there are also two 25-ton and four 60-ton furnaces of the Wellman rolling type. The annual capacity of these ten furnaces is 175,000 tons of ingots and castings.

Stock for charging the furnaces is loaded at the mills of the stock piles in boxes on freight cars, which are carried on an inclined track to the charging floor and placed directly in front of the furnace doors. The boxes are picked up, pushed into the furnace, emptied and replaced on the car by Wellman electric charging machines, of which there are three in use. All doors and valves of the furnaces and regenerators are operated by pneumatic cylinders, the cocks of which are worked by a boy on the charging floor. The melted steel is tapped into ladles of 30 to 60 tons capacity, which, being suspended from a traveling crane during casting, are at once taken to a pit full of empty molds. A steel-lined casting pit 30 ft. deep permits the casting of ingots of great size and weight, up to 150 tons each. The making of small and intricate castings is quite as carefully attended to as of those of greater size.

The plate mill was built simultaneously with the open-hearth building. There are five large reheating-furnaces served by two Wellman electric charging cars. Two plate trains, one 90-in. and one 132-in. in length of rolls, are driven by a 54 in. by 66 in. Porter-Allen engine of 3,000 horse power. They are three-high, having the middle roll operated vertically by hydraulic pressure. Finished plates are made from 3-16 in. to 1 1-2 in. thick and up to 126 in. wide and 60 ft. long. The capacity of the mill is 84,000 tons of finished plates a year. Much of the machinery in these two departments is electrically driven. A high speed of movement and ease of handling plates of any size rolled are obtained by the use of strong electro-magnets, suspended from traveling cranes, which will pick up, transport and lay down plates simply by turning a switch.

Shears of great strength cut plates to any size or shape ordered. One of these shears cuts circular plates with great accuracy. The largest shearing machine has blades 11 ft. long, capable of cutting a plate of that width and 2 in. thick.

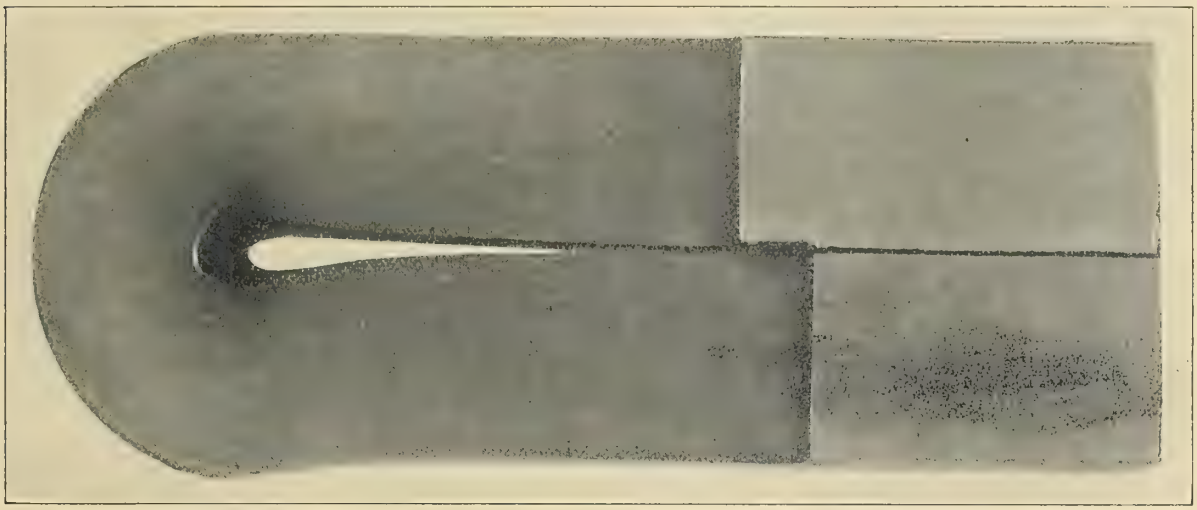
TESTS OF OIL AND COAL AS FUEL ON THE HYDRAULIC LIFEBOAT QUEEN.*

BY JOHN PLATT, M.E.

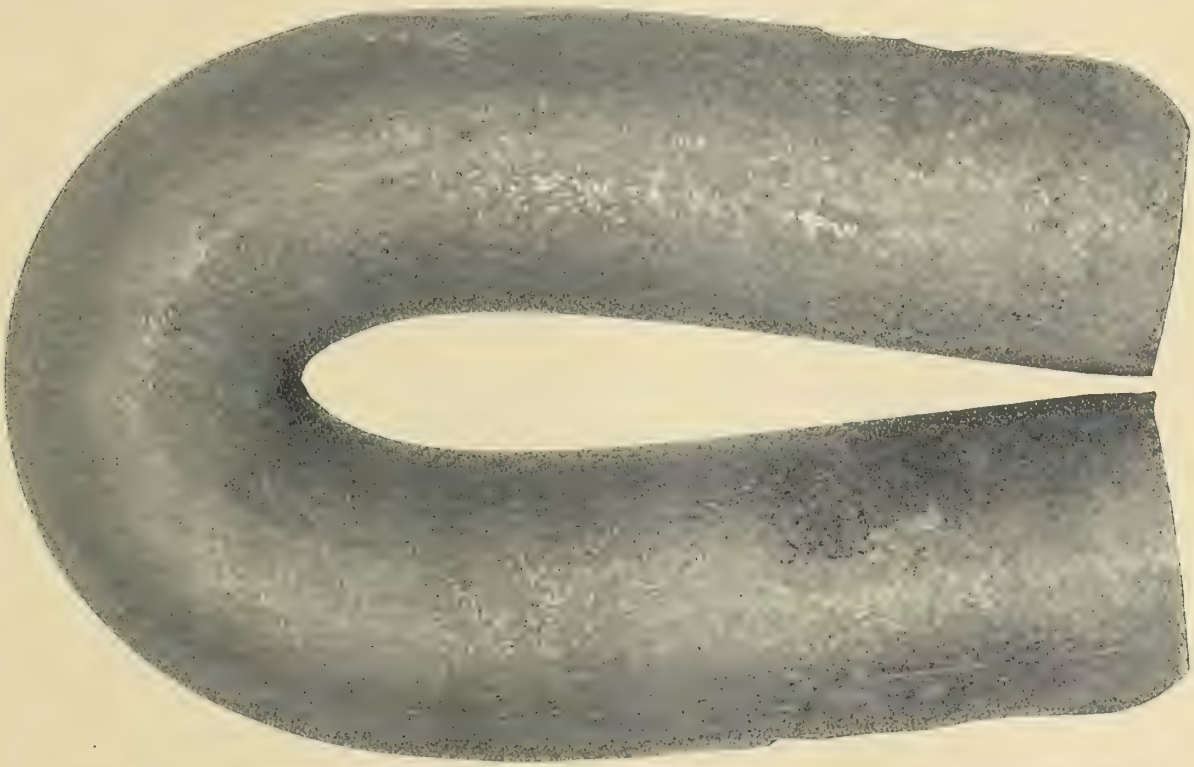
A series of experiments having been made burning both coal and oil in a Thornycroft boiler in the new hydraulic lifeboat Queen,[1] built by John I. Thornycroft & Co., for the Royal National Life Boat Institution, it was thought that a general description of the boat and the results of the experiment would be of interest to the members of the American Society of Naval Engineers.

The general question of hydraulic propulsion has been dealt with by S. W. Barnaby, in a paper before the Institution of Civil Engineers.[2] He also describes a previous hydraulic lifeboat the "President Van Heel."[3]

The vessel was designed by G. L. Watson, the naval architect to the Royal National Lifeboat



COLD BEND TEST, 1 15-32 IN. OPEN-HEARTH STEEL PLATE FOR MARINE BOILER.—SEE PAGE 18.



COLD BEND TEST 2 5-8 IN. DIA. OPEN-HEARTH STEEL FOR STAY BOLTS.—SEE PAGE 18.

* From a paper read before the American Society of Naval Engineers, Washington, D. C.

1 For illustrated description of this boat see January issue, page 17.

2 Proceedings of Institute of Civil Engineers, London. Vol. 77, p. 1.

3 Proceedings of Institute of Civil Engineers, London. Vol. 130, part IV.

Institution, who furnished drawings and a specification, the builders, John I. Thornycroft, being responsible for the design of the machinery, and for the attainment of a speed of 8 1-2 knots.

The particulars of the vessel which is named the "Queen" are:

Length over all	55 ft.
Length on W. L.	53 ft.
Breadth moulded	13 ft. 6 in.
" over sponsons	15 ft.
" extreme over belting	16 ft.
Depth moulded	5 ft. 6 in.
Draught extreme	3 ft. 6 in.
Displacement	30.08 tons.

The hull is closely subdivided, and the bulkheads are intact, the only watertight doors being in the coal bunker bulkheads. Access is obtained to the small compartments for the purpose of examination and painting by manholes jointed with red lead in the bulkheads above the water line. Longitudinal wing bulkheads extend for a length of 25 ft. 6 in. on each side, enclosing the machinery space. They are 2 ft. 6 in. from the side at the height of the water line amidships. They considerably reduce the volume of the machinery compartments, which are unavoidably long, and afford security in case of injury to the boat's sides. The wing compartments are subdivided by athwartship bulkheads, and on each side of the boiler room one of the compartments thus joined is used as a coal bunker. Two strong side protective keels of American rock elm are fitted between angle bars, the bolts going through the flanges of the bars, and not through the bottom plating. These are placed under the longitudinal side bulkheads, and are an effective protection to the pump inlet and to the bottom. In the stern is the open cock pit capable of holding about forty-five people. The deck of the cock pit is above the water and watertight. It is provided with the usual freeing valves to allow of the rapid exit of the water in case of a sea being shipped. The rudder projects below the bottom of the boat in the usual lifeboat fashion; the rudder head is hexagonal in section for a length of about two feet, and can slide up and down in a quadrant into which is geared a worm spindle which carries the steering wheel at its inboard end—the rudder can rise if it strikes the bottom, or can be triced up with tackle provided for the purpose without disconnecting the steering gear. At the forward end of the cock pit, upon the engine casing, is a steam capstan, and a steel wire rope hawser is coiled on a reel close to it. A wire rope nipper is placed upon the forecastle and an arrangement is provided for cutting the hawser in case of need. There are two sails, a dipping lug and a fore stay sail. The mast can be hinged down upon the top of the boiler casing.

A double compound surface condensing inclined engine is used, having cylinders 8 1-2 in. and 14 1-2 in. in diameter, by 12 in. stroke. The air and bilge pumps and the two feed pumps are driven from the main engine. An independent engine and circulating pump supplies water to the condenser. The usual auxiliary feed pump is placed in the boiler room. The main turbine and casing are of bronze, zinc protectors being provided to prevent galvanic action between pump and the shell of the boat, should the zinc coating of the latter be worn off. The inlet pipe is of steel and the discharge pipes are of copper. The diameter of the turbine is 2 ft. 6 in., and at a speed of 9 knots the discharge is about 2,240 lbs. of water per second. The nozzles are 9 in. in diameter. These nozzles are carried well forward and aft. The distributing or reversing valves are placed at the junction of the ahead and astern discharge pipe. The nozzles for propelling astern are above water and are protected by the belting. These are bronze castings bolted to the pump casings. They are square in cross section and the valve moves from side to side and directs the water into the ahead or astern pipes as desired. When placed in mid position dividing the stream the boat stands stationary. The design of the inlet is such that the water is conveyed to the pump without shock, and the cross section immersed areas of the hull in way of the inlet are so formed as to allow the water to enter the pump without disturbing the natural flow of the stream lines.

The weights of the vessel are:

	Tons of 2,240 lbs.
Huli	11.23
Fittings	1.77
Woodwork	1.61
Propelling machinery	7.89
Engineer's stores	0.33
Boatswain's stores	0.30
Fuel, crew, and passengers	6.95
Total	30.08

The metacentric heights with all weights and a full load of passengers is 1.77 ft. A series of trials was run with the "President Van Heel" to measure the I. H. P. required to drive the vessel at different speeds. The boat was brought to a draught of water corresponding with a displacement of 30.08 tons. The guaranteed speed of 8.5 knots was obtained with 123 I. H. P., the engines working at half power. With 246 I. H. P. the speed was 9.29 knots. Much power is wasted by hydraulic propeller when driven far above its designed speed. The object of providing such a large reserve of power in the boat was not that she might be driven at a greater speed than 8.5 knots, but to ensure that the power wanted for this speed might be obtained without difficulty under the arduous conditions of the service.

A Thornycroft water tube boiler of the "Speedy" type is fitted in the boat. The effective heating surface is 610 sq. ft. and the great area is 11.4 sq. ft. The steam pressure is 150 lbs. per sq. in. and the test pressure 300 lbs. The drums are of Siemens-Martin steel, 5-16 in. thick, increased to 9-16 in. at the tube plates. The tubes are of solid drawn steel 1 in. external dia., No. 14, B. W. G. thick. It was found that the boiler did not prime although the movements

of a vessel of this class are very violent when running in a sea way. Steam can be raised from cold water in 20 minutes. The boiler was fitted for burning both coal and oil fuel. It was first fitted with two "Holden" oil burners operated by steam. A 1 3-4 in. bore oil fuel main runs across the front of the boiler below the ash pit doors, and a 3-4 in. bore pipe is led up from this on either side to connect with the burners. A 3-8 in. bore steam pipe is led to each burner. The result

the relative position of the burner to the air admitted into the fire box, and whether it is admitted above or below the fire bars. Where the oil is burned in conjunction with the coal, it is found that if the greater part of the air is admitted above the fire bars, a smaller proportion of the coal will be burned, and there will be a greater tendency to smoke. On the other hand, by admitting a large proportion under the fire bars, the whole is more rapidly burned, and the con-

TRIALS OF THORNYCROFT BOILER FOR HYDRAULIC LIFEBOAT QUEEN.

		Oil Trials.					Coal Trials.		
Number of trial	1	2	3	4	5	6	1	2	3
Duration	65 min.	1¼ hours.	30 min.	30 min.	45 min.	45 min.	2 hours.	1 hour.	2¼ hours.
Atmospheric pressure	29.5" Mer.	29.63" Mer.	....	....	....	29.62" Mer.	29.61" Mer.	29.98" Mer.	29.84" Mer.
Air pressure in funnel	1.26" Wat.	1.35" Wat.	1.4" Wat.	....	1.97" Wat.	2.42" Wat.	1.52" Wat.	1.52" Wat.	2.13" Wat.
Air pressure in uptake	0.95" "	1.3" "	....	....	1.6" "	2.04" "	104" "	1.36" "	2.01" "
Boiler pressure	1.40 lbs.p.□"	142 lbs. □"	153.75 lbs. □"	152.5 lbs. □"	160 lbs. □"	156.0 lbs. □"	158 lbs. □"	128.4 lbs. □"	162.3 lbs. □"
Temperature of air	55.3° F	59.3° F	55.7° F	55.0° F	56.6° F	59.0° F	57.4° F	53.7° F	59.8° F
Temperature of feed water	51.2° F	51.5° F	50.5° F	50.0° F	51.3° F	51.0° F	50.22	52.2° F	56.4° F
Temperature of oil	109.3° F	153.1° F	150.2° F	97° F	88.75° F	61.1° F	....	....	....
Temperature of casing, front	145.4° F	....	....	....	....	....	152.7° F	129.6° F	107.1° F
Temperature of casing, side	87.0° F	....	....	....	....	....	89.3° F	68.4° F	100.8° F
Temperature of casing, back	132.6° F	....	....	....	....	....	134.8° F	129.8° F	128.6° F
Temperature in uptake	729° F	693.3° F	710° F	703.3° F	781.2° F.	671° F	787° F	728° F	787° F
Factor of evaporation	1.213	1.219	1.215	1.217	1.216	1.217	1.217	1.21	1.21
Total oil consumed	412.8 lbs.	443 lbs.	101.43 lbs.	111.39 lbs.	222.5 lbs.	175 lbs.	....	....	....
Oil consumed per hour	381 lbs.	354.4 lbs.	202.86 lbs.	222.78 lbs.	296.6 lbs.	233.3 lbs.	....	....	....
Oil per hour per sq ft of grate	33.4 lbs.	31.1 lbs.	17.7 lbs.	19.5 lbs.	26.01 lbs.	22.2 lbs.	....	....	....
Coal consumed with oil	129.9 lbs.	196 lbs.	84 lbs	112 lbs.	76.5 lbs.	141.0 lbs.	....	....	....
Total coal consumed	....	....	....	....	....	....	1,289 lbs.	536 lbs.	1,182 lbs.
Coal consumed per hour	120 lbs.	157 lbs.	168 lbs.	224 lbs.	102.0 lbs.	188 lbs.	644.5 lbs.	536 lbs.	524 lbs.
Coal per hour per sq. ft. of grate	....	....	....	....	....	....	56.55 lbs.	51.0 lbs.	50 lbs.
Total water evaporated	4,920 lbs.	4,095 lbs.	1,840 lbs.	1,660 lbs.	29.75 lbs.	3,065 lbs.	7,495 lbs.	3,650 lbs.	9,905 lbs.
Total water evaporated per hour	4,560 lbs.	3,276 lbs.	3,680 lbs.	3,320 lbs.	3,966.6 lbs.	4,086.8 lbs.	4,747.5 lbs.	3,650 lbs.	4,400 lbs.
Total water evaporated per hour, from and at 212° F.	5,531.28 lbs.	3,993.4 lbs.	4,471.2 lbs.	4,040.4 lbs.	4,823.3 lbs.	4,980 lbs.	5,770 lbs.	4,420 lbs.	5,320 lbs.
Water evaporated by coal	957.41 lbs.	1,442 lbs.	619 lbs.	825.4 lbs.	563.8 lbs.	1,039 lbs.	....	....	....
Water evaporated by oil	3,962.5 lbs.	2,653 lbs.	1,221 lbs.	834 56 lbs.	2,411.2 lbs.	2,026 lbs.	....	....	....
Water per lb. of oil	9.5 lbs.	598 lbs.	12.03 lbs.	7.4 lbs.	10.85 lbs.	11.56 lbs.	....	....	....
Water per lb. of oil, from and at 212° F.	11.52 lbs.	729 lbs.	14.60 lbs.	9.0 lbs.	13.17 lbs.	14.07 lbs.	....	....	....
Water per lb. of coal	....	....	....	....	....	....	7.37 lbs.	6.82 lbs.	8.4 lbs.
Water per lb. of coal from and at 212° F	....	....	....	....	....	....	8.97 lbs.	8.25 lbs.	10.17 lbs.
Water per hour per sq.ft effect heating surface	7.47 lbs.	5.37 lbs.	6.03 lbs.	5.44 lbs.	6.5 lbs.	6.72 lbs.	7.46 lbs.	5.98 lbs.	7.22 lbs.
Water per hour per sq. ft. of grate	400 lbs.	287.3 lbs.	322.8 lbs.	291.2 lbs.	347.9 lbs.	389.5 lbs.	399 lbs.	348 lbs.	419 lbs.
Horse power (water per hour 20)	228 hp.	163.8 hp.	184.0 hp.	166.0 hp.	198.33 hp	204.38 hp.	237.38 hp.	182.5 hp.	220 hp.
Grate area	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	10.5 sq. ft.	10.5 sq. ft.
Effective heating surface	610 sq. ft.	6.10 sq. ft.	6.10 sq. ft.	610 sq. ft.	610 sq. ft.	610 sq. ft.	610 sq. ft.	610 sq. ft.	6.10 sq. ft.

given must not be taken as an exposition of the "Holden" oil burning system—the contractors simply using this particular burner to make their experiments with.

A great number of trials were made without taking measurements of fuel, etc., as it was necessary to make a number of preliminary trials with each of the different positions of burners, before the boiler could be made to work without making excessive smoke, which seems to depend on

sequent higher temperature causes a better combustion of the oil, and there is less tendency to smoke formation. Under these conditions a humming vibration is often set up, which vibrates the boiler casing, and is objectionable.

A series of tests were made with the furnace covered in with a brick arch, which when it reached a white heat effectually prevented smoke and gave the best result. It was found, however, that the large mass of brick took a long

time to get heated, which made the boiler so much slower at raising steam.

Trials were also made with the fire bars covered with pieces of broken brick, a small part being kept clear to light up with coal, which was also covered with brick when steam had been raised, and the boiler heated up. It was, however, found impossible to keep these oil burners going without the addition of some coal.

After completing the preliminary trials it was found that under the conditions necessary in this boat, one burner was sufficient when placed quite close to the surface of the coal.

The table gives the particulars of both the coal and oil trials when measurements were taken.

The boiler was steamed where finished in the yard without any special setting up. The feed water was pumped in with a duplex pump; the water being measured in tanks. The steam was blown off through the main stop valve. The draft was induced, or, in the case of the oil fuel, assisted by a steam jet in the funnel.

The coal used was Nixon steam navigation coal; on trials Nos. 1, 2 and 3 Astatki (flash point 310° F.) was used as liquid fuel, being heated by a steam coil to make it more fluid. On trial 4, 5 and 6 Wells' oil (flash point 195° F.) was used, not being heated before being injected into the furnace. The liquid fluid was brought into the furnace by "Holden" jets, steam being used for injecting the oil. In trial 1, two burners were used, being placed well apart, on trials 2, 3 and 4, one burner was used, placed in the center, on trials 5 and 6, two burners placed together in the center slightly diverging and pointing upwards were used. On trial 6 a brick arch 4 1-2 in. thick had been built into the furnace, with a clearance of 2 in. between it and the water tube arch. There were in the brick arch forty-five holes 3 in. by 2 1-2 in. giving a flue area of 338 sq. in. This arch reduced the grate area from 11.4 sq. ft. to 10.5 sq. ft.

The water evaporated by the coal in the oil trials was calculated for an evaporation of 7.37 lbs. of water per lb. of coal, as found from the first coal trial.

Nixon steam navigation coal was used on the coal trials. On trials 2 and 3 the brick arch, as described under oil trials, was used, but not, however, in trial 1.

The author gives the particulars of these trials, simply as a result of some experiments made, to find out the best and simplest means of using oil as an auxiliary on a lifeboat. The results must not be taken as those that can be obtained by the use of the Holden burner, as this would not be at all fair to that system; nor must they be taken as giving the maximum amount that can be evaporated using oil under such a boiler.

The author is indebted to the builders of the boat, J. I. Thornycroft & Co., for the particulars of the trials, and for the drawings of the boiler and the boat. Also to Sidney W. Barnaby, M. Inst. C.E., for the general description of the boat.

REPORT OF THE "MAINE" NAVAL COURT OF INQUIRY.

(Last installment.)

Commander James M. Forsyth, U.S.N., commandant of the Key West Naval Station, was called:

Q. When did the *Maine* coal here recently—since her coming down from the north?

A. Twice.

Q. What coal did she receive, and how much each time; the kind of coal, I mean?

A. She received anthracite coal, 280 tons at the first coaling, and I think 270 tons at the second. I have a memorandum of that.

Q. Refer to that paper.

A. This is taken from the log of the station; 280 tons at the first, and 271 tons at the last coaling.

Q. Can you give the dates of the coalings?

A. Yes, sir; the first was December 20 to 22, 1897, and the second January 18 and 19, 1898.

Q. Did she receive the coal from the pile which you have examined?

A. No, sir.

Q. What became of the coal that was in that pile at that time?

A. The coal that she received was mostly Morea coal from the Morea coal mine; anthracite Morea coal.

Q. That has all been given to ships?

A. It has all been given to ships. There may be a few tons of it left outside, on the eastern end, but I am not sure, because the two coals were mixed; but her main body of coal that she received was Morea coal. I would further say that she may have received some red-ash coal that was sent down later from the *Natalie*. There may have been some carloads of the *Natalie* coal; but the main body of her coal was Morea.

Charles Goodwin, foreman of the government machine shop at Key West, was also examined with reference to the coal stored there for naval ships.

Q. Did you, about the middle of February, receive an order from the commandant of this station to make an inspection of the coal pile for infernals?

A. I did, sir.

Q. Do you remember when you received the order?

A. I received it on last Saturday, a week ago.

Q. Did you carry out the order?

A. I did.

Q. In what way?

A. I had all the pile of coal turned directly over, so that I could see through every particle. I had two assistants with me, but I was there all the time myself. Not a particle of coal was left unturned over—of the anthracite coal, not the bituminous coal. There was bituminous coal there, too. Of the anthracite coal there was not a particle that was not turned thoroughly over, so that I could see through the whole of it.

Q. Was anything found wrong by anybody during this work?

A. Nothing at all.

Q. What did you expect to find?

A. I thought I might find some unforeseen bombs or something like that. That is what I expected. I found one piece of coal with a hole drilled through it, but that was nothing more than where they drilled to blast it. I was careful, of course, to see. I could tell pretty near the difference between the coal and any substance of iron or anything that way.

Q. You could have seen a bomb or a piece of pipe or anything of that sort?

A. Anything that way. I found one old tin can with some white lead in it. That might have dropped from the ship.

Chief Engineer Howell, of the "Maine," was recalled and his attention called to a large piece of cement which had fallen on the deck of the Ward liner City of Washington at the time of the explosion:

Q. Will you examine this piece of cement and identify it if you can?

A. I saw that piece of cement on the *City of Washington*, and now identify it as the same piece. My opinion is that it was blown from the *Maine*, and came from underneath the berth-deck blower on the port side.

Q. Upon what do you base your opinion?

A. That blower was not placed at right angles to the bulkhead on the forward side, and this piece of cement shows marks of an angle similar to the acute angle, which is the base of the blower.

Q. Is it not a very heavy piece of cement for the base of the blower?

A. I do not know exactly how this cement was, but I believe it was 2 1-2 inches thick, similar to this. I mean to say, I do not know how thick that cement was, but this piece is about 2 1-2 inches thick, and that is a very reasonable thickness to put either. The cement has also indications of oil on both sides of it, and I also know that that cement had oil on the under side, because I have seen oil drop through from that deck down into the bunker underneath. This cement showed oil on both sides while on the *City of Washington*. The marks of rivet heads on this cement and the imprint also of the angle iron and the running in line, similar to the acute angle I have spoken of before, which is also another indication that it came from the bottom of that blower. I should say that the top and bottom sides are parallel.

Gunner's Mate Schluter, who was engaged in the diving operations, was recalled before the court and asked:

Q. Have you been down diving since you gave your last testimony?

A. Yes, sir. I was down yesterday.

Q. Please tell to the court what you did and found.

A. I was dressed and lowered down by order of Mr. Powelson to look for boilers, if I could find them. While I was down, crawling down a little ways I found a boiler. I crawled all around it and all over it, and found it to be in good condition. Then, while I was on top of the boiler, I hit my helmet up against a plate overhead, and while crawling up on top of there I found a piece of wire. This wire looked to me not to belong to the ship, so I cut off a piece of it and sent it up on the line. After Mr. Powelson had inspected it, he called me up, and then sent me down again, telling me to saw off a piece of the wire and send it up. I went down again in the afternoon and tried to locate it, and did so after an hour or so. I tied the line to it and pulled in as much slack as I could, then sawed it off. Then I signaled for them to haul it up. They took it on board the *Fern* to Mr. Wainwright, who said it was telephotos wire.

Commander George A. Converse, of the U. S. S. Montgomery, who has seen thirty-six and a half years' service, and has made a special study of explosives, having had many years' experience in torpedo work, was called:

Q. Did you, while at the torpedo station, have many opportunities to witness the explosion of submarine mines?

A. Yes, sir; very frequent opportunities.

Q. What material—what explosives were used?

A. Gunpowder, nitroglycerin, dynamite, and gun cotton.

Q. What quantities of these materials have you seen used for such purposes at any one time?

A. The largest quantity I have ever seen used consisted of a torpedo containing 300 pounds of gunpowder and 200 pounds of dynamite, all in separate cases—100 pounds in each case—securely lashed together. Single charges of gunpowder of 150 pounds; charges of nitroglycerin of about 100 pounds; charges of dynamite of about 100 pounds, and charges of gun cotton of about 120 pounds.

(A plan of the forward magazine and shell room of the *Maine* was then shown to the witness.)

Q. Examine that blue print, Captain Converse, and tell the court if, in your opinion, one or more of those magazines should explode or partically explode in that ship would such an explosion lift the forward body of the ship partly out of the water?

A. I don't think it would lift the ship out of the water.

Q. Will you please give the court your reasons for thinking so?

A. I think that the body of the ship, water borne in all directions, would tend to offer a resistance which would cause a general effect of a large explosion to be exerted upward; and that an explosion tending to lift the ship up would necessarily have to be diffused over a very large surface.

Q. Suppose that a submarine mine explodes adjacent to the side or bottom of a ship thus water borne; what will be the direction of the explosion?

A. It exerts some effect in all directions, but the most violent effect in the direction of the least resistance, and that depends entirely upon the depth of the explosion below the surface of the water. I believe it to be possible to explode moderate charges of gunpowder against the sides of a strong ship and do very little damage, if the center of the charge is comparatively near the surface of the water; but if the center of the charge is well below the surface of the water, so that it will afford a large amount of water-tamping, then an injury will be done to the ship, while there will be comparatively little disturbance of the water at the surface.

Q. Supposing the charge to be a large one, and placed under the bottom of the ship where the water is only 8 or 10 feet below the bottom of the ship, what will be the direction of the explosion?

A. It would depend very much upon the position of the torpedo with regard to the bottom of the ship; that is to say, whether the torpedo was in close contact with the bottom, or was lying on the ground at some distance below the bottom of the ship, with water intervening. If the torpedo contained a large amount of explosive, and were placed in contact with the bottom of the ship, it is my opinion that it would endanger the ship by blowing a well-defined hole through it. The size of the hole depends, of course, upon the distance of the center of the charge from the skin of the ship. If, however, the charge is on the bottom of the harbor, and a depth of water of several feet intervened between it and the bottom of the ship, I think the tendency would be to lift the ship bodily; in other words, it would cause a large upheaval of water similar in effect to a large wave striking the ship, at a point directly over the mine—would tend to lift the body of the ship at that place exactly as the crest of a wave.

Q. In case of the explosion of a submarine mine under the bottom of a vessel, as you have described it, the effect upon a vessel, either in lifting her bodily, of blowing a hole in the bottom, would depend upon the size of the charge and its proximity to the bottom of the ship, would it not?

A. Yes, sir.

Q. If the charge is sufficiently large, and near enough to the bottom of the ship, both of these phenomena would take place—ship lifted up and the bottom blown in?

A. Yes, sir. A point to be taken into consideration is the nature of the explosives employed. Gunpowder is the more moderate explosive, and tends to produce a greater upheaval of water, as a rule, than do the more violent explosives, which, in proportion to their violence seem to cut a hole out of the water, lifting in the shape of a fine spray all that directly above the charge. To illustrate this point, and the injury sometimes done by high explosives, I cite the case of the *Aquidaban*, which, according to authentic photographs, had holes blown completely through from one side to the other by charges of gun cotton; whereas I have seen wooden vessels of comparatively good size, in which large quantities of gunpowder have been exploded, without injuring the vessel to any great extent, there being in the latter case simply a large upheaval of water, to which the vessel rose and fell exactly as she would have done in a heavy sea.

Q. What is your experience, Captain, in the case of the explosion of a submarine mine, as to what becomes of the mine; of the case itself?

A. I have rarely seen any considerable pieces of mine, whether they consisted of powder or of more violent explosives which have been found; they are almost invariably ruptured and lost.

Q. That is to say they are not blown up?

A. They are blown up. That is noticeable in the case of spar torpedoes, in which I have exploded gunpowder and gun cotton, in cases made of wood, cast iron, copper, and steel, and perhaps other metals. In all my experience I do not recollect to have seen any considerable pieces of any case after an explosion. Sometimes small fragments of cast iron have been seen, and, on one or two occasions, thrown into a boat, indicating a complete demolition of the case containing the explosive.

Q. In the case of a submarine mine that was exploded under the bottom of the ship, and containing sufficient explosive to completely destroy the ship in that region, would your remarks about the submarine mine case itself apply to the bottom of the ship which is submerged, not referring at all to the interior portion of the ship?

A. In the case of all mines the form of the mine is usually such as to contain only the amount of the explosives used, and hence there must be a rupture of the case for the gases to escape. Were the mine in contact with the ship, or quite close to it, I think the effect on the bottom of the ship would be—depending, of course, upon the size of the mine—to blow to pieces that part of the ship directly over the center of the explosion, and rending and tearing the bottom of the ship from the center in different directions, the amount of damage depending entirely upon the quantity and nature of the explosive employed. In other words, that the violent explosive would cut a hole, blowing that part that was cut out into small fragments, and that the size of the hole would depend entirely upon the size of the charge employed.

Q. Captain, will you please examine the sketches which have been shown you and tell the court whether, in your opinion, the explosion of one or all of these forward magazines, or their partial explosion, would leave the bottom of the ship in the condition which now exists, as represented in these sketches?

(Exhibit H was shown witness.)

A. The sketch might represent two explosions of entirely different natures. That part of the sketch represented here as frame 14 1-2 to frame 18 1-2, aft, in a direction of frame 23, might be produced by the explosion of a comparatively large mine of not violent explosive matter at some distance below the bottom of the ship; whereas the part abaft of frame 23 has all the appearance of the effect produced on iron plates by a high explosive in close proximity to it. There are in all explosions two general effects: First, the upheaval of the water, caused by the direct action of the explosion, followed almost immediately afterwards by the second upheaval of water and mud, being the reaction of the water from the sides and the bottom, which rushes in to fill the crater produced by the first explosion. But the location of this upheaval and the distortion of the keel in the present instance does not appear to have been formed by the secondary effect referred to above. It is too far forward; too remote. It is too far from the place marked "Débris," which must be somewhere about frame 27. If that is 27, then the distance, as marked, from frame 18, will be eleven frame spaces, or 44 feet forward of what would appear to be the crater of the most violent explosion.

Q. Then to what kind of an explosion do you attribute the force that caused this bending of plates and keel on sketch?

A. I am of the opinion that it could be produced by the explosion of a submarine mine containing a large amount of the lower explosives—gunpowder or similar—not in contact with the ship, but some distance below it, perhaps on the bottom.

Q. Looking at the sketch shown you, especially at that portion of the keel which has frame 18 on top, and the plates—bent plates—forward of it, excluding entirely all portion abaft of it, could this part which you are now told to consider have become so distorted from the effects of an internal explosion alone?

A. I do not think it could. I have never seen anything in my experience which would lead me to believe that it is possible to produce the effect indicated by any explosion within the interior of the ship in that immediate vicinity.

Q. Looking at the sketch shown you, and informing you that the forward 6-inch magazine and the fixed ammunition room were at that part of the keel which is represented as nearly vertical—that is, frame 18 to frame 24—could the conditions as shown forward of frame 24 have been caused by an explosion of those two magazines, or of any magazine abaft of frame 24?

A. I do not think it could.

Q. Do you think, then, necessarily, there must have been an under-water mine to produce these explosions?

Q. Indications are that an under-water explosion produce the conditions there.

Q. Looking at the plan of the *Maine's* forward 10-inch and 6-inch magazines, would it be possible for them to have exploded, torn out the ship's side on both sides, and leave that part of the ship forward of frame 18 so water borne as to raise the after portion of that part of the ship, drag it aft, and bring the vertical keel into the condition that you see on the sketch?

A. It is difficult for me to realize that that effect could have been produced by an explosion of the kind supposed.

Q. You said in your previous testimony that the distortion of the plates forward of frame 18 could have been caused by an outside mine of moderate explosive power. Could such a mine, if producing that effect, also set fire to the magazine?

A. I am unable to answer that question.

Q. Can you consider it possible, under any circumstances, to have a portion of the 6-inch magazine exploded and not all the powder in that magazine explode? If so, please state under what circumstances this would be possible.

A. I think I am positively certain an explosion might occur without exploding all the powder in separate tanks.

Q. But if the explosion originated on the inside of the magazine, without any water on the inside of it, would it not be almost certain that all the powder in that magazine would explode?

A. I think it would be much more certain.

Lieutenant Commander Wainwright recalled:

Q. Have you kept an account of the powder tanks that have been sent up out of the wreck of the *Maine*?

A. Only in my memory.

Q. Can you state to the court about how many have been sent up of each kind, and also their condition?

A. About thirty-five 6-inch and about ten 10-inch. I have seen one 10-inch tank and two 6-inch tanks that contained powder in bags, and the remainder were either empty and contained parts of excelsior packing or parts of powder bags. All the tanks were more or less injured, a large proportion opening lengthwise along the seam. Nearly all the tanks show signs of having been subjected to outside pressure, as if pressed against the powder inside; and their ends are also crushed in.

I saw two 6-inch tanks that were opened at the seams and were pressed down flat, as if by an exertion of considerable force. Those two have more the appearance of having been exploded, in my mind, than any other, and though not the appearance I would expect powder tanks to exhibit after a charge inside had burst. Others are not sufficiently destroyed to give me the impression of having been exploded, although I have never seen powder tanks after an explosion and can only draw my own dieas. The damage to the tanks seems to have been caused by contact with some hard object, and as the shells were found on top of these tanks accounts for the damage.

Q. How was the *Maine* made fast to her buoy at the time of her destruction?

A. Starboard bow chain.

Q. Do you know whether there was any private ammunition on board the *Maine*—that is, ammunition belonging to individuals and not to the Government?

A. None that came to my knowledge.

Much of the time of the court was taken up with examination of the several naval and wrecking company's divers who went down and reported the damage to the structure of the vessel. It was upon this information, of course, that the findings of the court were based, and consequently the results of these investigations made by the divers will be found concisely stated in the report of the court printed at the commencement of this article. (Commenced in May issue.)

Inspection Vessel at Buffalo.

Our illustration shows a very handy inspection vessel built for the United States Army Engineer's office at Buffalo by the Craig Ship Building Co., of Toledo, Ohio. She is built of steel on tug lines, and is 70 ft. long, 15 ft. 6 in. beam and is fitted with a compound engine, in dimensions, 12 in. and 22 in. by 16 in. stroke, and a Taylor water tube boiler built by the Detroit Screw Works. There is a commodious pilot house forward and a good sized cabin aft with passage all around. The boat will be used principally for use in superintending the work of breakwater construction at Buffalo. Major Thomas W. Symons, U. S. A., in charge of the Engineer Corps at Buffalo, advises us that the boat is very safe and fast and is satisfactory in all respects.

U. S. ARMY ENGINEERS' INSPECTION VESSEL AT BUFFALO, N. Y.

It is understood that the Government will soon commence a regular service of troop and supply ships between New York and Santiago de Cuba and Ponce, Porto Rico. The vessels for this service will probably be those recently purchased from the Atlantic Transport Line by the Government, and which were described in our August issue. A vessel will be dispatched from New York about every five days. The proposition is made that in addition to the War Department uses, these vessels shall carry mail matter for the Post Office Department. The ships which have been engaged as transports will be thoroughly overhauled and disinfected, and many special appliances, including distilling, ventilating and ice plants, will be installed before they are put on the route.

FORMER TRANSATLANTIC LINER ARIZONA NOW ON THE PACIFIC COAST.

As an illustration of the highly specialized types of steamships for different trades the renovation of the S. S. "Arizona" is an interesting case in point. Many of our readers will recognize in the picture of the two-funneled steamer the former Trans-Atlantic liner "Arizona," which in her days of triumph on the western ocean was probably the most talked of steamship afloat. To-day, if in her original condition, she would not be counted in the first class among trans-Atlantic liners, so great has been the increase in size, speed and accommodation in the nearly twenty years which have elapsed since she was built. But the S. S. "Arizona" that was has been transformed into one of the most modern and complete vessels sailing to any port in the far eastern trade. Through the courtesy of Messrs. Carlill, Dodwell & Co., the shipping agents of Tacoma, Wash., we are able to show the steamship as she now appears, equipped for service on the Pacific. A glance at the "before and after" views will show great changes in exterior appearance. Two funnels have been replaced by one, and in place of the old, heavy rig there are now four trim poles carrying triangular sails. There have also been some changes made in the upper works. Many would express a preference for the ship-shape appearance of the Guion liner "Arizona," though with her present rig and the former and less obtrusive smoke pipes she would probably look more symmetrical and yet strictly up to date.

When the now defunct Guion line brought out the "Arizona" for the New York-Liverpool trade there was consternation among its competitors. She was built by John Elder, at Govan on the Clyde, and was designed to show her heels to any liner afloat. On her trial trip she steamed at the rate of 17.3 knots, with 6,630 indicated horse power, and on her maiden voyage she covered the distance from Queenstown to New York in 7 days, 11 hours and 49 minutes. In subsequent voyages she reduced this time, and held the record until more powerful ships were put in service. Soon after she came out—November 7, 1879—she ran into an iceberg in mid-ocean and her bows were carried away. The forward bulkhead remained staunch, and the sudden stoppage of the vessel did not injure the machinery. She proceeded to St. John, N. F., and there temporary repairs were made, and subsequently, under her own steam, she recrossed the Atlantic and was permanently repaired at her builder's yard.

She is an iron vessel 464 ft. long, 45.2 ft. beam, and 35.7 ft. deep. Originally her load draught was 18 ft. 9 in., and her gross tonnage 5,164 tons. She is fitted with eleven bulkheads, eight of which are watertight and five are carried up to the upper deck as a protection from fire. For the Atlantic trade she had accommodation for 140 first-class passengers, 70 second-class, and permanent quarters for 140 steerage. Upon the lower deck accommodation for 1,000 steerage passengers could be arranged for. She had a single screw and compound engines of inverted type with three cylinders and three cranks. The high pressure cylinder was 62 in. dia., and this was set between the two low pressure cylinders, which were each 90 in. dia., all having a 5 ft. 6 in. stroke. At full speed she turned up 55 revolutions per minute. Her propeller was 23 ft. dia. and 33 ft. pitch.

There were six double-ended and one single-ended boilers, each 13 ft. 6 in. dia., and 18 ft. and 10 ft. long respectively. The total grate area was 780 sq. ft., and heating surface 19,500 sq. ft. The working pressure was 90 lbs. per sq. in., and the daily coal consumption was 125 tons.

She is a good model, her block co-efficient being .589 and her midship co-efficient, .895. After the Guion line went out of existence the "Arizona" lay idle for several years, until the present year, when she was sold for service on the Pacific coast. She was sent to her builder's yard (now the Fairfield Company), and left there in March in the condition the recent photograph shows. She was put in commission by the Northern Pacific Steamship Company and later sold to the Northern Pacific Railway Company, which company placed her at the disposal of the United States Government for carrying troops to the Philippines.

The changes made in the interior arrangements of the vessel were extensive. Her passenger accommodation was, of course, much too extensive for trade on the Pacific; consequently she was rearranged to carry 40 first-class passengers amidships and 1,000 steerage passengers below. The intermediate passenger quarters were entirely removed and the additional space available gave opportunity to make the cabin accommodation unusually spacious and airy. Her holds are now arranged for carrying tea, of which 6,100 tons measurement could be stored away, and there is also a lead lined chamber provided for transport of silk, which is very profitable freight. New machinery was fitted with triple expansion engines and new boilers built to carry the additional pressure. The rate of speed maintained in the transatlantic trade was not necessary on the Pacific route, so less power was fitted, and on her trial trip this spring she averaged 15 5-8 knots. A very complete equipment of auxiliary machinery and deck appliances was supplied, and should the Arizona be again put in the Pacific passenger trade she will likely prove as popular a vessel as she was on the Atlantic several years ago.

The Polynesian Steamship Co. has been incorporated under the laws of New Jersey to establish a line of steamships from San Francisco to Honolulu, the Philippine Islands and Tahiti. The capital stock is $1,500,000. The incorporators are C. R. Flint, R. A. Smith, B. Hatch, and W. M. Ivins, of New York, and others.

GUION LINER ARIZONA WHEN SHE HELD THE ATLANTIC RECORD.

S.S. ARIZONA AS SHE NOW APPEARS—A PACIFIC LINER.

IMPROVED APPARATUS.

Asbestos Air-Cell Fire Board.

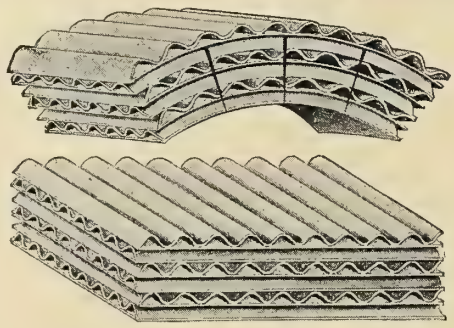
Strong claims are made for the efficiency of the asbestos air-cell fire board by the manufacturers, who recently caused a series of tests to be carried out. A pine board covered with various materials, the asbestos board included, was exposed to the blast of hot gases. The temperature of the gases striking the protecting material was around 4,000 deg. F. With a coating of varnish 1-50 in. thick the board ignited in 1-3 second; with a protection of 1-20 in. of sheet iron, the board ignited in 15 seconds, and with 1-4 in. to 1 in. of asbestos board, the time of ignition varied from 7 minutes to 60 minutes. This board is sent out from the factory flat, and can readily be bent to shape for boiler coverings or for use in structural shipwork as an insulating material. It is also made in the form of sectional covering or air-cell lagging for covering pipes. These coverings are manufactured by the Asbestos Manufacturing Co., 291 Douglass street, Brooklyn, N. Y.

Knorr-Norris Course Indicator.

The Knorr-Norris Course Indicator is a simple device for lightening the labor of the navigator recently put forth by Theodore Alteneder & Sons, Philadelphia. On a heavy square card is printed a circle marked with the points of the compass over the degrees of the circle. Above it is a round card, marked in the same way which revolves around a center. The center is of glass and in it is fastened a string. The instrument is used instead of parallel rulers in finding the courses and bearings on charts, being easier and more accurate. It gives, at the same time, true and compass bearings, and prevents mistakes in the application of the variation of the compass. The lower card represents the chart and has lines on the edges by which it may be accurately placed on the meridian. The upper card represents the compass. In use on Mercator's Charts the card is placed on the chart with the center over the position of the ship and adjusted to the meridian by the marks on the edges. The upper card is adjusted to the variation of the compass. The string is stretched to the point to which the course is directed and indicates on the upper card the compass course and on the lower card the true bearing. On charts of conic projection the indicator is adjusted to the parallels always over the position of the ship and will show the bearing of any point. The indicator may also be used as a cyclone card to find the bearing of the center of the storm. This indicator is copyrighted by Thaddeus Norris.

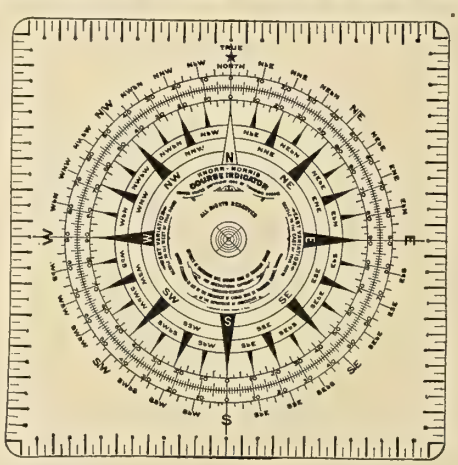
Regal Flexible Metallic Packing.

A novel style of packing which the manufacturers style "metallic" is shown in the illustrations herewith. It consists of a composition of "metal and graphite" in granular form encased in thin plaited cotton tubing. This lubricating element in composition with the metal is said to insure permanent and perfect lubrication, resulting in a reduction of the friction and wear of the rods. The grains of this packing are very irregular in shape. The metal used is of medium hardness so as to stand any class of work, and is



FORMS OF ASBESTOS FIREBOARD.

thoroughly impregnated with the lubricating element, graphite. The metal is so compounded that the expansion and contraction due to varying temperatures is almost imperceptible, and the point of fusibility is much greater than the temperature of superheated steam at any pressure. The packing is placed in the stuffing box in the ordinary manner—breaking joints with each ring and compressing with the gland. The grains do not solidify; they simply pack very tight and close together; but each grain remains separate and distinct from every other, thus making it easy to overcome any leakage that may result in time by slight compressions and allowing the easy removal of the packing from the stuffing boxes in case the engine is overhauled. The thin cotton tubing, which is next the rod



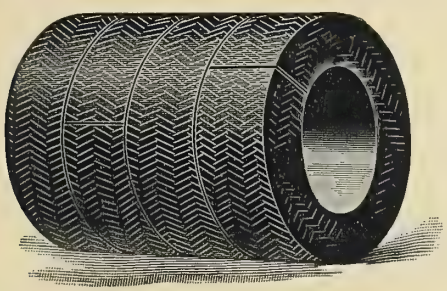
KNORR-NORRIS COURSE INDICATOR.

when the stuffing box is packed, wears off in a few hours' time, leaving a highly polished and perfectly lubricated surface in contact with the rod, as shown in the illustration. Should the packing ever be removed from the stuffing boxes it will be found to come out as easily as it was

put in, and will readily crumble back into its original granular form, and can be put in new tubes, ready to be used again. It is applied in the ordinary stuffing boxes without alterations or disconnections, and the manufacturers assert there is no tendency to cut or wear the rods. It is made in all sizes by the Regal Packing Co., Fisher Building, Chicago, Ill.

Bausch & Lomb-Zeiss Binoculars.

Scientific research which has made possible the modern improvements in engine construction and electrical apparatus, for examples, has also been the cause of a great advancement in the construction of optical instruments. The Bausch & Lomb-Zeiss stereo field glass is the most important application of these discoveries to marine work. Unless a person has tested one of these binoculars it is difficult to clearly state the tremendous improvement over the old forms. In the sectional view of the glass here published the peculiar arrangement of prisms will be noticed. By using double reflecting prisms the

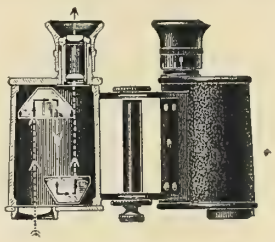


REGAL PACKING AFTER COMPRESSION.

image formed by the object lens is inverted and brought to a focus much closer to the object glass than would be possible without it. It is a well-recognized fact that in order to obtain good optical results an object lens of comparatively long focus must be used in any telescope. In the ordinary forms this long-focus object glass produces an inconveniently long instrument.

REGAL PACKING READY FOR USE.

The inverted image formed by the object glass of the ordinary telescope has to be viewed either with a concave eyepiece, which results either in poor definition or a small angular field, or with the terrestrial eyepiece, which in this case is extremely long and thus increases the length of the telescope unduly. Furthermore, the terrestrial eyepiece, if made short enough to be useful at all on a hand glass, gives more magnifying power than is desirable, and has an angular field no greater than that of the concave eyepiece. The reinversion formed by the object lens, by means of a double refracting prism, makes it possible to use



BAUSCH & LOMB MARINE GLASS.

the celestial eyepiece. This not only has a much greater angular field, but a much flatter field, as well, and has a greater light transmitting power. The angular field of the best Galilean and terrestrial telescopes heretofore constructed was not over 2 deg. in the powers of 6 dia. or above, whereas the 6-power of the glass here described has an angular field of 9 deg. This feature makes the stereo field glass extremely valuable for marine work, as a large horizon can be scanned without changing position of the observer or of the eyes, and furthermore, the emerging beam of light from the eyepieces is so calculated that the eye takes in the whole of the field without shifting from one edge of the eye lens to the other, and the field is equally distinct at the edge and in the center. The placing of the object lenses farther apart than the eyepieces are is also a great advantage for marine work, as it gives a stereoscopic solidity to distant objects, which makes them stand out appreciably from other objects in the same line of vision. It is a fact familiar to users of the ordinary binocular field glasses that objects near the limit of vision, with the glass, appear to be bound together by a sort of indistinct haze, which prevents the seeing of details clearly or the recognition of the exact forms of the objects. In the stereo field-glasses the increased distance between the field-lenses gives a much greater parallax and eliminates this indistinctness; hence, with a stereo field glass objects can be seen farther and more distinctly than with an ordinary binocular of the same magnifying power. These optical advantages combined with the extreme lightness and compactness of the construction make it a specially desirable glass for marine use. The glass out of which the prisms are formed is a special glass made on purpose for this use. It is almost of the hardness of rock crystal and of extreme transparency and brilliancy. This is necessary in order that the prisms may not tarnish after long exposure to the air, and may not decrease in any way the volume of light entering the glass through the field-lenses.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.

S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representatives.

L. L. CLINE, Detroit, Mich., 47 Hodges Building.
B. M. GARDNER, Chicago, Ill., 1522 Monadnock Block.

Traveling Representatives.

E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

THERE is a wide-spread belief in shipping circles that a great expansion of trade in home bottoms will follow the signing of a treaty of peace. Not only will the former Spanish possessions in the West Indies be under the control of the United States, but some form of proprietorship in the Philippines will give an advantage to American shippers, from home ports at least. Then trade with Hawaii will undoubtedly show a rapid development, especially when the country again directs its energy to peaceful pursuits. The trade which has been carried on at the various ports in these countries in recent times is consequently a subject of the greatest present interest. The most recent and accurate statistics obtainable are those contained in the Review of the World's Commerce for the years 1896-97, just issued by the Bureau of Foreign Commerce of the Department of State at Washington. From this we shall give a few totals which will be instructive. Porto Rico is about the same length as Long Island, but nearly eight times as wide. There are about 150 miles of good roads inland, nearly 500 miles of telegraph line, and 300 miles of railroad built or building. The most recent figures of imports and exports available are those for 1895, which show a total value of imports of $16,155,056 and exports of $14,629,494. These figures are a good deal less than the totals for 1894. Of the imports, rice of the value of $2,180,004 was the principal item. Next meats and fish aggregated about $2,800,000. Other items in excess of $100,000 in value, were coal, iron, soap, flour, vegetables, olive oil, wine, cheese, and provisions. Every one of these items could be readily filled from here. The exports were: Coffee, $8,789,788; tobacco, $646,556; sugar, $3,747,891, and honey, $517,746. Of the articles imported, the United States led with coal, petroleum and wood, but most of the manufactured goods came from Europe. The machinery used in the island was imported almost exclusively from Great Britain and Germany, a condition of affairs which ought not to last many months longer. In 1897 the trade of the United States with Porto Rico reached, in imports, $2,181,024, and exports, $1,988,888. In the year 1896 the total weight of the principal exports from the island was 96,838 tons, more than half of which was sugar. The Philippine Islands, according to the commercial reports, afford great opportunities. For risky, though very profitable investment, they now present a fertile field. In 1896 the imports into the islands were valued at $10,631,250, and the exports at $20,175,000. About 13 per cent of the imports came from Spain, and about 50 per cent of the exports went to the United States. The chief exports from the islands to this country were hemp and cane sugar, with much smaller amounts of vegetable fiber and straw goods. Although there are about 8,000,000 natives and 25,000 Europeans in the islands there are only 123 miles of railroad, running from Manila to Dagupin, in operation. English locomotives are now used. There is a monthly service of Spanish steamers between Manila and Liverpool, several lines to Hong Kong, and many coast lines between Manila and the other ports on the islands. Cuban trade is, of course, a more familiar subject, but it is appropriate here to reproduce a few facts concerning the island. In area it is about the size of the state of Pennsylvania. The imports of Cuba during the fiscal year ending April, 1896, were valued at $66,166,744, and the exports at $94,395,536. Official figures of the trade of the United States with Cuba in 1893 show imports valued at $78,706,506, and exports at $24,157,698. In 1897 these figures had dropped down to $18,406,815 and $8,259,776 re-

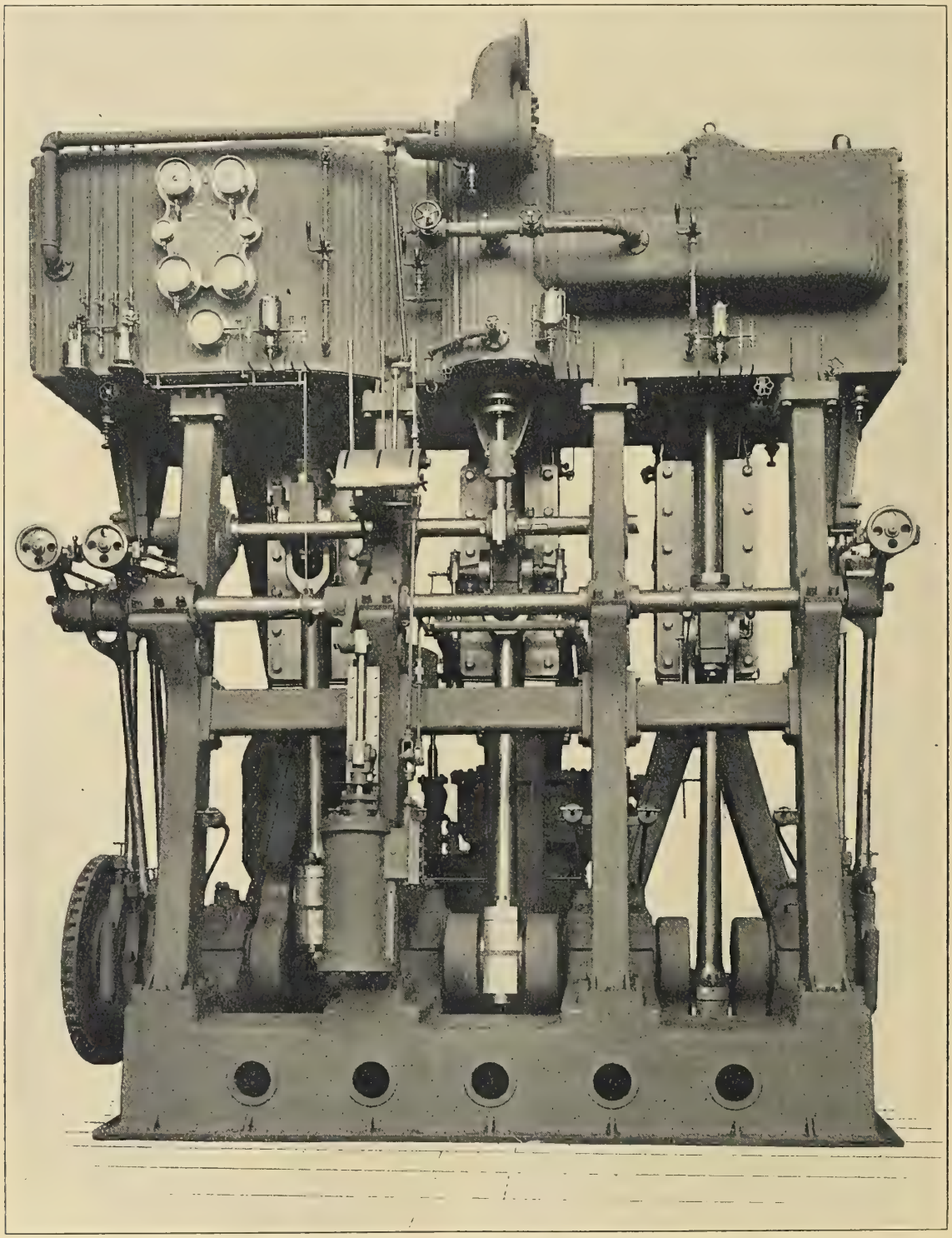
spectively. The commerce of Spain with Cuba in 1896 was: Imports from Cuba, $4,257,360, and exports to Cuba, $26,145,800. Besides the tremendously valuable tobacco and sugar crops of Cuba she has a considerable mineral wealth, which is imperfectly developed. The chief imports are cereals, meat products and manufactured goods, all of which needs could best be filled by this country. The railroad development includes about 1,000 miles of main lines owned by various small companies. In general the country is as backward as might be expected under Spanish rule. Trade with Hawaii is at present largely in the hands of the United States. In 1896 we took 99.64 per cent of her exports and sold her 76.27 per cent of all imports. The total value of Hawaiian exports in 1896 was $15,515,230, and imports $7,164,561. In their order of value the exports ranked, sugar, rice, bananas, wool, coffee, hides. At the present time Hawaii imports "almost everything she uses," the attention of the islanders being chiefly taken up with the raising of sugar.

RULES and regulations for the Paris Exposition of 1900 have just been issued from the office of the Commissioner-General of the United States, at Chicago. The Exposition will open April 15 and close November 5. In addition to the Exposition proper there will be a retrospective Centennial Exposition arranged among the different classes, and which will endeavor to display the progress in various branches of production since the beginning of this century. There will be also various intellectual competitions and congresses held, the details of which have not yet been announced. As might be expected, the General Classification, which covers almost every form an exhibit might take, is very extensive, and under the head of Civil Engineering-Transportation there is a subdivision (Group IV, Class 33) which is styled "Equipment for Mercantile Navigation." This in detail covers a very wide range of theoretical and practical work, from raw materials to finished models of ocean steamers. We have no doubt the shipbuilding and allied interests of this country will take this opportunity of showing the real position of America, in its actualities and possibilities. The whole civilized world has had a wonderful exposition lately of the efficiency of a home-made American ironclad navy. In 1900 there will be an opportunity to show the world what our builders can do in the construction of vessels for the contests of peace. A splendid showing could be made by the shipbuilding interests, if not as individuals then as a unit, in a grand display of models. The American liner, the Great Lake freighter, the Sound steamer, the Mississippi stern-wheeler, and the whaleback are some of the typical boats. There is no better reason now why ships should be built in Europe for America than in America for Europe or any other place, no matter how remote, where a customer exists. The material men, engine builders, and manufacturers of the various auxiliary and deck appliances for ships would also find it to their interests to be represented. Already they are ahead of the builders in booking foreign orders. This would be a fit matter for the Society of Naval Architects and Marine Engineers to discuss at its forthcoming meeting.

CONTINUAL reports of the wretchedly insanitary condition of army transports returning from Cuba with sick and invalided soldiers calls attention to this peculiarity of vessel construction, or, shall we say, marine life. The condition on the transports is only an exaggeration of what occurs in miniature on many a vessel in every-day trade. A vessel is the last place in the world for a sick man. It would seem, generally, indeed, that ships were built to be inhabited by men of rude health, and that there is no duty for the sick man to do except die. A very interesting investigation along these lines has been made by Dr. A. Wellesley Harris, the medical officer at the port of Southampton, England. This is a port of call for as crack a lot of passenger ships, engaged in various trades, as could be found anywhere, and a splendid station for observing the best in the way of hospital accommodation aboard ship. After an inspection of twenty-eight such vessels he finds there is a necessity for great improvement in these matters: Situation and surroundings of the hospitals; cubic capacity provided for each patient; ventilation and lighting of the hospital; lavatory accommodation; proportion of berths to crew and passengers. His recommendations include: Location of hospital on the poop deck, with separate lavatory; means of isolating two separate varieties of infectious disease, and provision for separating the sexes; air space to each berth not less than 200 cubic feet, with proper inlets and outlets.

SMASHUP OF THE ENGINE OF THE LAKE PASSENGER STEAMER MANITOU.

A serious smashup of the engines of the steamer Manitou of the Lake Michigan and Lake Superior Transportation Line occurred early in the morning of August 6. The vessel was on one of her regular passenger trips bound from Mackinac to Chicago. When about twelve miles south of Point Betsey and four miles from land a bolt in the low-pressure connections of the engine broke, and in a few seconds the engine was a wreck. Fortunately, the steam mains were not ruptured, and Chief Engineer Peck and his assistants promptly shut the boiler stop valves. When the break occurred the steam barge Algonquin was close to the Manitou, and an agreement was made for a



TRIPLE-EXPANSION ENGINE OF THE LAKE MICHIGAN PASSENGER STEAMSHIP MANITOU.

tow, the Algonquin taking the disabled steamer into Manistee, where a number of the passengers took train for Chicago. Subsequently the Algonquin towed the Manitou to South Chicago, where repairs are now being executed by the Chicago Shipbuilding Co.

By reference to the engraving of the engine of the Manitou a clear conception of the nature of the mishap can be had. The engine is of a design which is very popular on the lakes, with staggered frames and slipper guides. The cylinders are 23 in., 38 in., and 62 in. by 36 in. stroke. Stephenson link motion is used, the eccentrics for the intermediate and low pressure motions being placed outside the frame at the after end of the crank shaft. Motion is communicatd to the intermediate valve, which is of the piston type, by a rock shaft. This permits the valve to be placed outside the center line of the engine, giving greater compactness and reducing the fore and aft length of the engine. The engine was fitted with the high-pressure cylinder forward, and the starting platform on the starboard side. Each connecting rod has a forked end with a fixed pin working in a bearing in the crosshead. The smashup started by the breaking of the inside binder bolt on tne low-pressure crosshead. This sheared off cleanly at the cap, the nut and screwed end of the bolt dropping down into the crank pit. On the next up stroke the piston rod and crosshead pulled away from the connecting rod, the remaining bolt giving way under the excessive strain. The piston kept on upward and the nut which secured the rod to the piston went through the low-pressure cover. This bent the rod, cockbilled the piston and split open the cylinder. Meanwhile the connecting rod had fallen outwards and wiped away two of the front columns, to one of which the starting engine was bolted. The crosshead cap with a short length of bolt, and one of the nuts in place fell into the crank pit. The thickness of this piece being greater than the clearance between the crank webs and the bed plate, the low-pressure crank was lifted, breaking the bed plate in two places, at the after main bearings. The weight shaft and many of the rods were badly bent, but no other serious fractures occurred. The bolt which broke in the first instance was of steel, 3 in. dia. It will be necessary to remove the engine and replace a considerable portion of it, the expenses of repairs being estimated at $30,000.

The Manitou is one of the best known passenger steamers on the Great Lakes. The contract for her construction was let in 1893 to the Chicago Shipbuilding Co., where her hull was built. The company at that time did not build engines, and so these were turned out of the shops of the Cleveland Shipbuilding Co. Her general dimensions are: Length, 275 ft.; beam, 42 ft.; depth, 24 ft. 6 in., and gross tonnage 2,945 tons. Her speed in regular service has been about 17 miles an hour. She has seen an amount of hard service in the several seasons since she came out. Her schedule called for three trips weekly between Chicago and Mackinac Island, a distance of 340 miles, between the dates of June 15 and September 15. She is a two-deck steel ship, fitted with seven bulkheads, and was built specially for passenger traffic, having 125 staterooms on board.

A serious mishap occurred to the lake side-wheel steamer Greyhound, August 19. She had left her wharf in Detroit with a picnic party, and had reached a point about two miles below the St. Clair canal, when apparently without any warning one of the main rods of the engine broke, and the engine was speedily wrecked. The damaged vessel is owned by the Star-Cole line, and it was only a few months ago she was extensively overhauled and had a considerable amount of repairs made to her machinery. Her engine is of the walking beam type, with cylinder 60 in. dia. and 12 ft. stroke. The connecting rod broke squarely across about 4 ft. from the crank end.

CORRESPONDENCE.

Against Favoritism in Naval Promotions.

Much has been very properly written and said of the injustice in promoting Commodore Sampson over Commodore Schley, but I have not seen a protest against the injustice of only advancing the chief engineers of the "Oregon" and other U. S. naval vessels three and two numbers, while the captains were advanced six and five.

Commodore Schley, Captain Clark and other commanders recognized how much was due to the Engineers' Department for the fine records made by the ships, and while every one is pleased over the promotions of the captains, the writer, with many others, think that the engineers have not received the proper recognition for services equally well and gallantly performed. I trust when the subject is presented to Congress that something will be done to show the Nation's appreciation of the heroism "below the protective deck."

RANDOLPH BRANDT.

Bids for U. S. Boats and Destroyers.

Bids for the twelve torpedo boats and sixteen torpedo-boat destroyers, recently described in these columns, were opened at the Navy Department, Washington, August 23. There were twenty-eight bids in all, some of which are as follows:

Bath Iron Works, Bath, Me.—Two boats, class 2, 29 1-2 knots, $161,000 each; four, $160,000 each; one destroyer, 400 tons, 29 1-2 knots, $292,000; two, $281,000 each; three, $280,500 each.

Columbian Iron Works and Dry Dock Company, Baltimore, Md.—One, two, three or four boats, 165 tons, 26 knots, $160,000 each. Class 2—One at $168,000; two, $165,000 each; three, $163,000 each; four, $161,000 each; same dimensions and speed. One destroyer, 28 knots, $293,000; two at $291,000; three, four or five, $289,000 each. Class 2, 28 knots, 420 tons—One or two, $282,500 each; three, four or five, $282,000 each.

Dialogue & Sons, Camden, N. J.—One destroyer, 29 knots, $293,000; two, $285,000 each.

Gas Engine and Power Company, Morris Heights, New York—One destroyer, 420 tons, $285,000; one destroyer, 420 tons, 29 knots, and one boat, 170 tons, 26 1-2 knots, $428,000; two destroyers and one boat, $708,000; two destroyers and two boats, $849,000; two destroyers and three boats, $987,000.

Harlan & Hollingsworth Company, Wilmington, Del.—Destroyer, 408 tons, 29 knots, $294,000; two, $291,000 each.

Lawley, George, & Sons, South Boston—Boats, 165 tons, 26 knots, one, $162,900; two, $159,400 each; Class 2—26 1-2 knots, one, $152,900; two, $149,400 each; Class 2 (another design), one, $157,400; two, $153,900 each.

Maryland Steel Company, Sparrows Point, Baltimore, Md.—$286,000 each; three of different specifications, $283,000 each; four, $282,000 each.

Neafie & Levy, Philadelphia, Pa.—Destroyers, 420 tons, 29 knots—One or two, $284,000 each; three, $283,000 each.

Nixon, Lewis, Elizabethport, N. J.—Boat, class 2, 26 knots, one, $168,000; two, $165,000 each.

Trigg, William R., Richmond, Va.—One boat, 150 tons, 26 knots, $160,000; two, $150,000 each; three, $129,750 each; four, $119,750 each. In a letter filed subsequently to the bid for torpedo boats, making no mention of size or speed, Mr. Trigg proposed to build one for $275,000; two, $260,000 each; three, $250,000 each; four, $240,000 each; five, $233,000 each.

Union Iron Works, San Francisco, Cal.—Destroyers, 400 tons, 29 knots, one $294,000; two or three, $285,000 each; destroyers, second class, same dimensions and speed, one, $294,000; two, $282,000 each; three, $281,500 each.

Wellington, Frank O., & Co., Fore River Engine Company, Weymouth, Mass.—Destroyer, 400 tons, 30 knots, and boat, 164 tons, 28 knots, $160,000 each; three, $159,000 each. This bidder varied the time of completing the boats and destroyers from ten to eighteen months.

Wolf & Zwicker, Portland, Ore.—One boat, 150 tons, 26 knots, $176,000; two, $165.000 each; three, $163,400 each; four, $162,500 each. Class 2—Destroyer, 420 tons, 29 1-4 knots, $289,000; two, $285,000 each; three, $282,000 each; one of 28 knots, $285,000; two, $291,000 each; three, $289,000 each.

The bids were chiefly made on department plans and where special bids were made on the bidder's own designs they are designated under the style of "Class 2" in the foregoing. After the opening of bids a representative of the Herreshoffs, of Bristol, R. I., put in a bid for two boats of 168 tons and 28 1-2 knots speed for $166,000 each. Mr. Trigg is connected with the Richmond Locomotive Works, which built the machinery of the Texas. Several prominent concerns, including builders of former torpedo-boats, did not submit any bids.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—XII.

BY WM. BAXTER, JR.

Having fully considered the construction and the principles of operation of electric generators, the next matter which concerns us is the manner in which the currents generated are conveyed to the apparatus in which they are utilized. It will be evident at once that this can be accomplished by means of the crudest devices, and this was actually done in the early days of electric lighting. If we had a boiler and an engine, located in the same building, we could operate the latter if we connected it with the former by means of a line of piping, and carried the exhaust away in the same manner; but it is evident that it would be a convenience to locate a valve at some point in the steam pipe, for without this the engine could not be stopped without blowing off the steam in the boiler. It is further quite clear that the position in which the valve were placed would largely determine its usefulness. If we had a number of engines, and these were supplied with steam by a number of boilers, the efficiency of operation of the plant would be increased if the connections between the engines and boilers were such that all or any number of the engines or boilers could be used at once and if any boiler could feed directly into any engine. To accomplish all this it would be necessary to run the piping in some systematic manner, and to locate valves of various kinds at points where through them the currents of steam could be controlled. The most perfect system of piping for this purpose would be the one that would facilitate to the greatest extent the future operation of the plant. A steam engine set up in the woods to run a sawmill is piped in any way that the conveniences at hand render practicable; on the other hand the piping system of a modern first-class ship is worked out with very great care, and every part is arranged so as to save space and to be in the most convenient position.

The connection of electric generators with the apparatus to which the current is supplied presents a case as nearly parallel to that described in the foregoing as the difference between steam and electric distribution will permit. In the case of steam the boilers are placed as near to the engines as practicable, while with electricity the distance between the generators and the apparatus operated thereby is generally, comparatively, very great. On this account the connections from the generator or generators are brought to a common point, and from here the distribution wires are led off. If we have a single generator its connection with the distributing circuits can be represented in its crudest form by the diagram Fig. 61, while Fig. 62 will serve to represent the connections when two generators are used. In Fig. 61 it will be seen that there are several devices in addition to the generator proper, thus there is the field regulating rheostat, marked *R*, whose office has already been explained, but we may repeat here that it is for the purpose of regulating the pressure or voltage of the current. The device shown at *b* is a fuse, which is a safety device, to open the circuit when the current becomes so great as to be liable to burn out the generator armature. *Am.* is an instrument used to measure the strength of the current and is called an ammeter. *J* is an electro magnetic device for opening the circuit when the current becomes too strong, and is known as a circuit breaker. It serves the same purpose as the fuse, but its action is such that it responds to instantaneous increases in current, while the fuse only acts with excessive currents of some duration. Either device alone can be used, but for reasons that will be given hereafter it is better to employ both. *V* is a volt meter, and is to electricity what the steam gauge is to steam, or any other medium acting under pressure. The current passing through this volt meter is taken from the points *m n* and thus has the full pressure of the generator. It can also be drawn from the points *m v*, as indicated by the wire *w*, and then it will show what voltage acts directly upon the external circuit.

The connections from the generator, after passing through the various devices, reach the points *c c*,

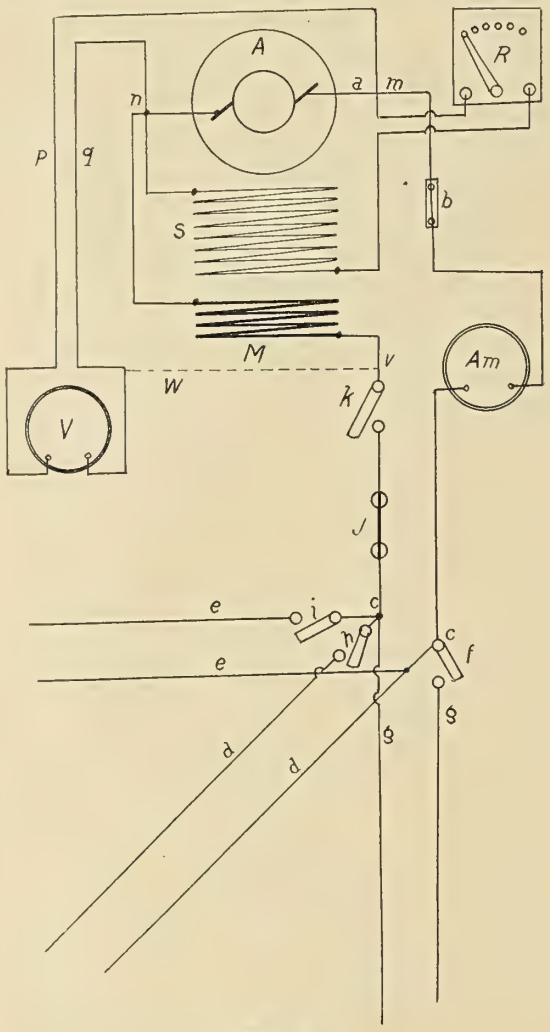


Fig. 61.

from which the external circuits are led off. The current flowing in the branch *g g* can be cut off by opening the switch *f*, and in the same way the currents in branches *d d* and *e e* can be controlled by switches *h* and *i* respectively.

In examining Fig. 62 it will be noticed that the connections are the same as in Fig. 61, except that the ammeter is placed in the wire leading from the magnet coil *M*, while the switch *k*, which is used for the purpose of opening the main circuit, is in the wire leading from the armature. From this it will be understood that it makes no difference on which wire the ammeter is placed so long as it is in the main line, for the current is of the same strength at all points. Another difference is that only one volt meter is used, and this is so arranged that by throwing the switch *s* to one side or the other it can be connected with the generator to the right or the one to the left, thus it can be used to measure

the pressure of the two machines, but not both at the same time. It is not really necessary to have a voltmeter in service all the time, and frequently they are not so used. An instrument that can be kept in circuit continuously costs more than one that can only be left in service for a few seconds, therefore the latter kind are often used for the sake of economy, but this practice is generally confined to small plants.

From a study of these two diagrams it can be seen that so far as the operation of the apparatus is concerned it is wholly immaterial where the various parts of the system are located so long as they are in the proper relation to each other; thus if the generators were in a small room the rheostats *R* could be placed upon one of the walls and the volt and ammeters upon another, while the several switches could occupy positions on all the walls. The wires connecting one with the other could also be run in any convenient or desired manner, but as in the case of the piping for a system of engines and boilers it is evident that the arrangement can be

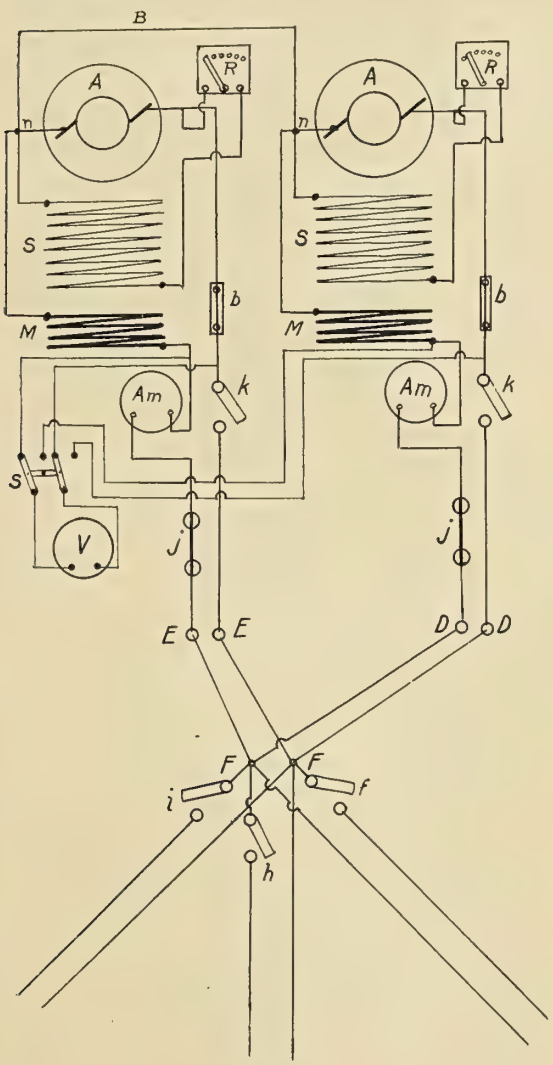


Fig. 62.

made far more convenient if all the switches and other devices are arranged in some kind of a system at one particular point. This at once leads us to the idea of a switch-board, but before proceeding to explain the general arrangement of these it will be necessary to explain the use of the wire *B* shown in Fig. 62. The arrangement of the various wires in this figure is such that the exact relation of *B* cannot very well be made out, it will therefore simplify matters to consider Fig. 63, from which the office of *B* will be fully understood. In this figure let the direction of the current in all the wires be as indicated by the arrow heads, then, if both machines develop the same voltage, the current flowing in *a* will be the same as that in *b*, and that in *c* and *d* will be twice this much. Suppose now that armature *A'* begins to run a trifle faster and in conse-

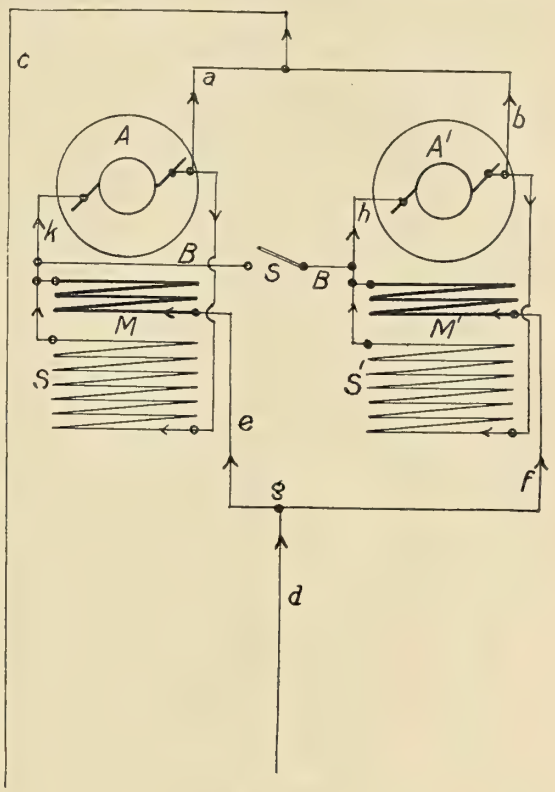


Fig. 63.

quence develops a higher voltage, the result will be that the current in *b* will be greater than that in *a*, and whatever the first gains the second will lose, for the sum of the two must remain equal, since it depends not upon the capacity of the machines to generate current, but upon the demand made by the devices in the external circuit. Suppose the wires *c* and *d* lead to a system of incandescent lamps, numbering say 500. As each lamp requires about one-half of an ampere, the total current would be 250 amperes. With both generators developing the same voltage, the current passing through each armature would then be about 125 amperes. If the current through the armatures is 125, that through the magnetizing coils *M M'* will be nearly as much, being less than that through the armature by the amount that passes through the coils *S S'*, which would be not over two or three amperes. The magnetizing action of the *M* coils is proportional to the strength of the current passing through them; therefore, if the current through armature *A'* increases, that through coil *M'* will increase, and as a consequence the machine will be magnetized more strongly, and this will further increase the voltage, resulting in a further increase of the current. On the other hand, the current in *A* being reduced, the magnetizing action of coil *M* is reduced, and the voltage of *A* is thereby further reduced, which results in a further reduction in the current

through it. Thus we see that a comparatively small initial increase in the current in one of the armatures results in a considerable final increase, because its effect is to cause the voltage to build up in the armature in which the increase takes place and at the same time to reduce in the other one. If the wire *B* is of large size, and as short as the conditions will permit, so as to have a very low resistance, the closing of the switch *s* will have the effect of reducing the difference in the current strength in the two machines to the lowest point. It accomplishes this result in the following manner: Suppose the switch *s* is closed and that armature *A'* begins to develop a greater voltage than *A*, then the current in *A'* will be greater than in *A*, but the currents in the coils *M M'* will be the same, for when the current in wire *d* reaches the point *g* it will meet about the same resistance in passing through wire *F* and coil *M'* to wire *h* as in passing through wire *e* and coil *M* to wire *k*. All the current reaching this last wire will not pass through it to armature *A* because the amount passing through the latter will be governed by the voltage it develops, but as the wire *B* affords a path for the surplus current this will pass by this path to wire *h*.

By resorting to this very simple expedient it will be seen that the difference between the strength of the currents in the two armatures is kept down to a point somewhat lower than that due to the initial difference in the voltage, and this is small compared to the difference developed when the wire *B* is not used. The difference is slightly less than that due to the initial difference in the voltage developed, owing to the fact that in consequence of the presence of the wire *B* the current must divide very nearly equally between the two coils *M* and *M'*, hence the two field magnets remain nearly unchanged in strength. In fact, the only difference in the strength of the field magnets is that due to the fact that a slightly stronger current will flow through *S'* and a slightly weaker one through *S*. If it were not for this difference, which is very small, the change in voltage and current would be no greater than if the fields were kept of constant strength by being magnetized by a uniform current from an independent source.

ENGINEERS' DICTIONARY—IX.

Boiler Mountings.—Various attachments to a boiler, such as steam and water gauges, safety valve, gauge cocks, etc.

Breeching.—A passage or uptake leading the smoke and products of combustion from the front connection of the marine boiler to the funnel or stack. Used also in referring to the sheet metal forming such passage.

Bull-ring.—A heavy continuous ring used in piston packing. In horizontal engines it takes the weight of the piston and in vertical engines keeps it properly centered. In its surface are cut one or more grooves which carry light metallic packing rings of the usual type, and by this means the joint between the piston and cylinder is made steam tight.

Carbonic acid or *Carbon-dioxide.*—In chemical symbols CO_2. The chemical compound formed by the complete union of carbon as in coal with oxygen. It is naturally one of the chief constituents of the gaseous products of combustion.

Carbon-monoxide.—In chemical symbols CO. A product of the union of carbon and oxygen in which less oxygen is absorbed than for the production of CO_2. In other words, it may be considered as partially burnt carbon. If it escapes with the gases of combustion without further combination with oxygen, it occasions a loss of about 70 per cent. of the heating effect of the fuel. Its escape unconsumed is, therefore, the source of a serious loss, and is to be carefully avoided. With the proper supply of air over the fire it readily burns with the peculiar bluish flame commonly seen soon after a fresh firing, and is thus reduced to CO_2, the completely oxidized product of carbon and oxygen.

Calorimeter.—(1) In general a heat measure or an apparatus for measuring quantities of heat. (2) The term is also used to denote the total cross sectional area through the tubes of a boiler, or the area for the passage of the products of combustion. (3) It is also used to denote an apparatus for determining the quality of steam; that is, the percentages in the form of vapor and of liquid. Modern steam calorimeters are of two forms, *separating* and *superheating.* The former consists essentially of a special form of separator which removes from a known or measured amount of steam all the moisture, at least within less than one per cent. The moisture being collected and weighed, and the steam from which it was separated being condensed and weighed, the desired proportions are readily found. In the superheating calorimeter advantage is taken of the fact that when a jet of steam escapes into the air from a much higher pressure, the vaporous portion tends to superheat itself, and this results in a drying of the steam as a whole. By an appropriate measurement of temperatures and pressures the degree of moisture in the steam may be determined. This type of calorimeter is only applicable when the entire amount of moisture is relatively small, for example, not over 3 or 4 per cent. In the *barrel calorimeter*, an older form, the steam to be tested was run into a barrel containing a known amount of water. By measuring the temperatures and amounts of water and steam, the quality could be found by computation.

Calorimeter-ratio.—A term applied to the ratio of the grate-surface of a boiler to the calorimeter or cross-sectional area of the tubes. The value of this ratio is usually from 5 to 8.

Caulking.—In boiler and ship construction, an operation for making riveted joints tight against liquid and vapor. It consists in beating down by means of special tools the edges of the metal against the face of the opposite plate. See Fig. 25. Such tools are known as *caulking irons or tools.* They are of two general types, either square or round nosed, as in the Fig. The latter is usually employed in modern practice.

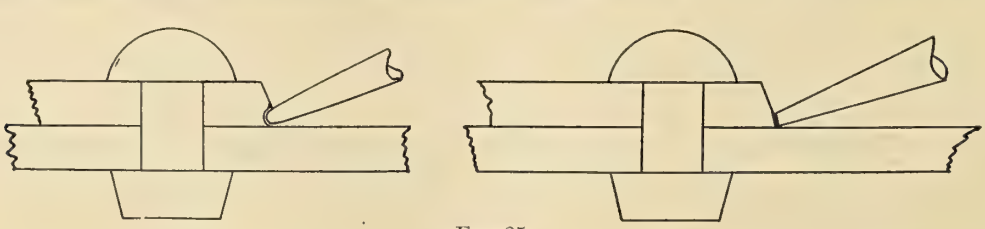


Fig. 25.

Channel-Plate.—A plate or frame in a *channel way* to which the air-pump *foot-valves* are attached.

Channel-way.—In the old form rectangular condenser, a passage leading water from the bottom of the vapor and condensed steam side of the condenser, to the air-pump suction.

Centrifugal Pump.—A form of pump in which the moving part consists of a number of vanes or arms attached to a shaft and revolving within a casing. See Fig. 26. The pump being *primed* or filled with water and started, the rotary motion gives rise to a centrifugal force, in obedience to which the water moves outward toward the tips of the blades, where

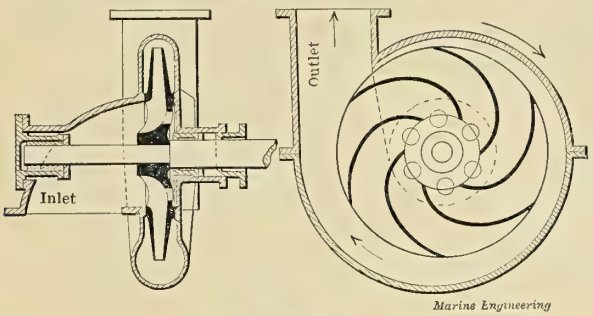


Fig. 26.

it escapes through an opening in the casing into the discharge pipe. Its place is taken by water entering through the suction near the shaft, and thus the operation continues. See also *blower*.

Check-valve or *Feed Check*.—A *self-closing* or *non-return* valve on the feed pipe near the boiler. See Fig. 27. The valve opens upward to an excess of pressure from the feed-pump and allows the entrance

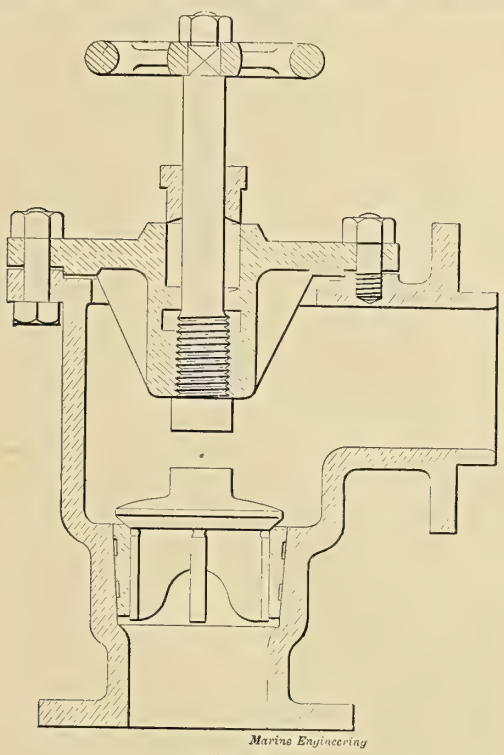


Fig. 27.

of the feed-water, but closes with an excess of pressure from above, and thus prevents the return or loss of the water between the strokes or when the pump is stopped.

Chute or *Shoot*.—A pipe or tube for conveying coal or ashes.

Circulating-Pump.—A pump used to force the water through the tubes of a surface condenser. It is usually of the centrifugal type. See *centrifugal pump*. The amount of water handled is usually from thirty to forty times the amount of steam condensed.

Circulator or *Hydrokineter*.—A device for aiding the circulation in fire-tube or Scotch boilers. The usual form of circulator involves some combination of conical discharge nozzles and passages working in a manner generally similar to the bilge siphon or to the injector. See *bilge siphon*.

Circumferential Joint or **Seam.**—In a cylindrical body, such as a boiler shell, a joint or seam running around the cylinder or in a plane at right angles to the axis.

Clearance.—In general, the least distance between a moving part of a machine and some portion of a relatively stationary part. In particular, the distance between the top or bottom of the piston and the top or bottom cylinder head when the engine is on the top or bottom center. Such distance is usually from 1-4 in. to 3-4 in., varying with the size and style of engine. This distance is also known as the *clearance proper*. The term *clearance* is also used to denote the volume between the face of the piston when at the end of the stroke and the face of the valve or valve seat, expressed as a percentage of the volume displaced by the piston in one stroke. This includes the volume due to the *clearance proper* added to that in the steam passages and ports. In amount it varies in marine engines from 8 to 10 per cent. to 15 or 20 per cent.

Coal.—The principal fuel for engineering purposes. It consists of uncrystallized carbon combined with volatile hydrocarbons and ash or incombustible matter. Hydrocarbons are chemical compounds formed of carbon hydrogen and oxygen in certain proportions. Coal may be roughly divided into two chief varieties, *Anthracite* and *Bituminous*, with intermediate grades, *Semi-anthracite* and *Semi-bituminous*, occupying the general middle ground between the two. In anthracite coal the proportions of volatile matter varies from 3 to 10 per cent; in semi-anthracite and semi-bituminous, from 10 to 20 per cent, and in bituminous, from 20 to 50 per cent. The amount of ash in good coal should not exceed from 10 to 15 per cent, while occasionally it falls as low as 5 per cent. Coal is also graded commercially, according to size, the chief terms being the following, and referring more particularly to anthracite coals: *buckwheat*, *pea*, *chestnut*, *stove*, *egg*, *broken* and *lump*.

Coal Heaver or **Passer.**—One of the engineer's force whose duty it is to bring coal from the bunker to the fireroom floor ready for use by the fireman.

Coaling.—The operation of taking coal on board ship from a lighter or wharf.

Coaling-port.—An opening in the side of a ship to facilitate the operation of coaling.

Collapse.—The failure of a tube or furnace by crushing inward, due to pressure on the outer or con-

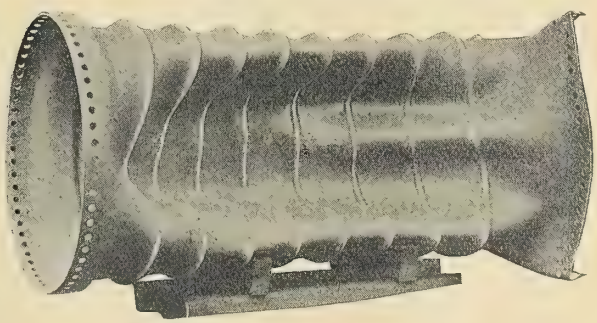


Fig. 28.

vex side. Fig. 28 shows the collapse of a modern furnace of a large marine boiler.

Collar.—A ring on a shaft formed either by forging and turning in place, or as a separate piece secured by pins or bolts. Its office is to prevent end play of the shaft, or to present a bearing surface for taking an end thrust on the shaft. A well known application is the *thrust bearing* of a screw steamer.

QUERIES AND ANSWERS.

Q. How shall I find the displacement of a ship of these dimensions:

Length between perpendiculars...280 ft.
Beam molded ..... 35 ft. 7 in.
Depth of hold ..... 19 ft. 9 in.

We will suppose the ship is drawing 14 ft., even keel. If there is anything else needed, add it, so as to illustrate the question. I only want to find it without a scale. SAN FRANCISCO.

A.—The displacement of a ship cannot be found accurately without a direct computation from the lines. Approximately, however, it may be found from the length, beam and draught by assuming a *block coefficient* or relation between the volume of the ship and that of a rectangular block which would just contain it. The volume of the latter would be the product of the three dimensions, length, beam and draught, and this multiplied by the coefficient assumed gives an approximate value for the volume of the ship. This must then be divided by 35, the number of cubic feet displaced per ton, and the quotient will give an approximate value for the displacement, more or less accurate according to the closeness of the assumed coefficient to its true value. The value of the block coefficient may vary from .35 or .40 to .75 or .80, but for ordinary mercantile ships is usually found between .60 and .70 or .75. Its value varies with the fineness of the ships, both in water-line and in section.

The above operation may be expressed by the following:

Rule—Multiply together the *length*, *beam* and *draught* and the product by the *block coefficient*, and divide by 35. The quotient is the displacement in tons of 2,240 pounds.

$$\text{Or displacement} = \frac{\text{length} \times \text{beam} \times \text{draught} \times \text{block coefficient}}{35}.$$

In the present case, assuming a value of .65, we have:

$$\text{Displacement} = \frac{280 \times 35\,58 \times 14 \times .65}{35} = 2{,}590 \text{ tons.}$$

For other values of the coefficient we should find as follows:

Coefficient.	Displacement.
.60	2,391
.65	2,590
.70	2,789
.75	2,988

Q. What is the difference between pressure and weight? T. M. G.

A.—*Pressure* means always a certain amount of force or load distributed over a certain area, as a pressure of 100 lbs. per sq. in., or a total pressure or load of 120,000 lbs. on a cylinder head, or a pressure of 2 tons per sq. ft., etc.

Weight means always the measure of the attraction of gravitation on a given amount of matter.

Both pressure and weight are, therefore, *force* in their ultimate nature, but their cause and immediate nature may widely differ. In some cases weight and pressure may be numerically the same, the pressure being simply the force due to the attraction of gravitation. Thus when a box is weighed on a platform scale the pressure on the platform is due to gravitation, and is the same as the weight; and in fact the

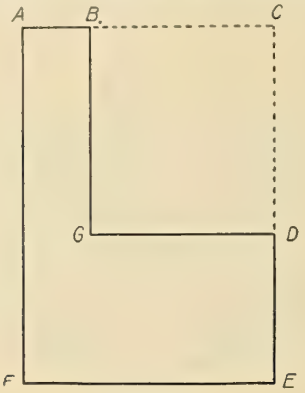


FIG. A.

scale simply measures this pressure transmitted from the box to the platform. In the case of a can of water shaped as in Fig. A we have an illustration of the difference between pressure and weight. The pressure in the liquid depends, as we know, simply on the depth, and therefore on the bottom E F the *pressure* will be uniformly distributed, and the same as though the can were of uniform size A C E F. We know very well, however, that the weight of the water in A B G D E F cannot be as great as in A C E F. How, then, is this extra pressure on the bottom of the can balanced so that when placed on a scale the indication will properly give the weight? The answer is found in the pressure upward on the face G D, which will be that due to the depth B G, and will therefore in amount just equal the weight of the water in the added part B C D G. We have, therefore, a pressure down on the bottom of the can equal to the weight of a volume of water A C E F, and a pressure upward on G D equal to the weight of a volume of water B C D G, and hence a *net* pressure or load transmitted from the can to the scale platform equal to the difference of these, or to the weight of the actual can of water, as desired. Here, then, weight is equal to a difference of pressures. Attention should also be paid to the difference between the pressure on the platform, which equals the weight, and the pressure on the bottom of the can, which, as we have seen, is greater than the weight.

As used by the engineer, the term *pressure* may refer to a force or load on a surface due to an elastic fluid, such as steam or compressed air, or to a force acting between two surfaces, such as the force acting between the slipper and the guides of a steam engine. The term *weight* is always used with its one meaning, as above stated, and, keeping in mind the relation between the two terms as above explained, no trouble should arise in any case likely to present itself to the engineer.

Q. In the dock trial of a ship, why is it that the engines never develop the revolutions nor the power which they would with the same steam pressure in free route; that is, steaming at sea?

FIRST ASSISTANT.

A.—In the issue of Marine Engineering for March last you will find a similar problem discussed, viz.: why, when

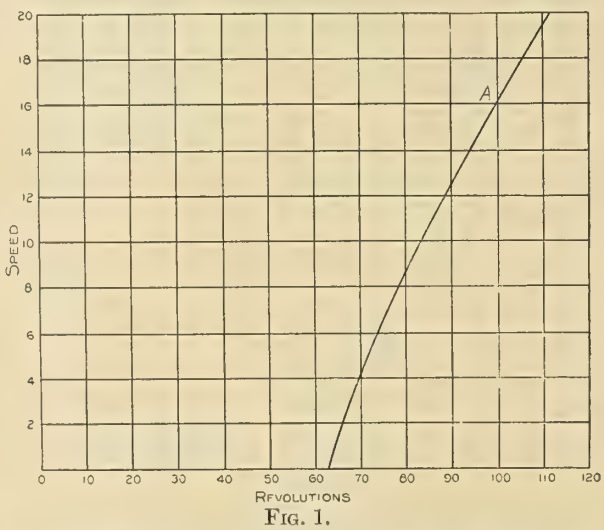


FIG. 1.

one ship is towing another, do the revolutions and power fall off as compared with the same ship running free with the same boiler pressure and cut-off?

Inasmuch as the question of dock trials has an interest and importance of its own, the principles spoken of in the former answer may be here developed somewhat more generally, and extended to the present subject.

Suppose, first, that the ship, boilers, engine and propeller are all properly designed for a certain speed. This means that with a given boiler pressure (say 180 lbs.) the boilers will be able to supply steam enough to drive the engines at the expected number of revolutions (say 100) and thus develop the designed power, while the propeller, with a certain slip (say 20 per cent), will drive the ship at the designed speed (say 16 knots). Now it must first be noted that all of these conditions go together, and if any one of them is disturbed it will react on all the others. The next point is that a constant set of pressures throughout the engine means a constant reduced mean effective pressure, a constant turning moment on the shaft, and a nearly constant thrust, and hence a nearly constant resistance overcome. Now if the resistance at the regular speed is increased, as by taking up a tow, what will be the immediate result? Evidently the speed will decrease until at some reduced speed the nearly constant developed thrust will balance the resistance, and the motion will become uniform again. The greater the increase in resistance at the regular speed, i. e., the larger the tow, the lower the speed at which the nearly constant thrust will be able to balance the resistance and thus produce steady conditions.

The whole question now turns on the *revolutions* at this reduced speed. In other words, how do revolutions and speed vary with constant turning moment and a nearly constant thrust developed or resistance overcome? This is best answered by experimental data, which give us a relation similar to that shown in Fig. 1. Revolutions are laid off horizontally and speed vertically. If we suppose that 100 revolutions and 16 knots are the designed conditions, as indicated by the point A, then the curve shows how the revolutions and speed vary for a nearly constant thrust. In particular the curve shows that as the tow is increased in amount and the speed for a

given thrust constantly decreases, so likewise do the revolutions decrease, though at a relatively slower rate, so that with the decrease of speed the slip constantly increases. Now the relations shown by this curve furnish the key to the whole question regarding the I.H.P.; for since the work done is a product of the revolutions into other factors, and since these other factors include merely dimensions of the engine and mean effective pressure, and since by assumption all of these remain constant, it is evident that under the conditions assumed the power developed will vary directly with the revolutions, and since the latter decrease with decrease in speed, so will the power decrease in like proportion. If we should continue to add to the tow indefinitely we should at length reach a condition similar to that of a vessel tied to a dock: that is, a condition in which the speed has become nothing and the revolutions reduced in marked degree. The exact relation between revolutions in free route and tied to a dock will depend on the special circumstances. The mean effective pressure remains the same, however, and the work done and power developed will therefore be decreased in the same proportion as the revolutions.

To state the thing in one sentence, therefore, the power falls off because the revolutions fall off, and the revolutions fall off because for a given propeller the turning resistance, which a constant pressure in the cylinders can overcome, is reached at a lower and lower value of the revolutions as the speed is made lower and lower.

The reason why of the facts expressed by the curve in Fig. 1, on which the whole explanation really turns, is to be found in the fundamental relation between revolutions, slip, thrust, etc., and a complete discussion of this phase of the question would exceed the proper limits of this reply. Once these relations accepted as experimental truth, however, the desired explanation is seen to flow from them as a necessary consequence.

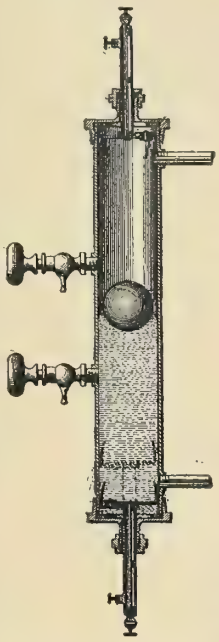
Q. Will you answer this question, which was asked in my examination: Do the crank-pin and piston travel the same distance? GREAT LAKES.

A.—The path of the piston is a straight line, and that of the crank-pin is a circle, whose diameter is equal to the piston travel. So far as their paths are concerned, therefore, they are entirely different in character. The circular path of the crank-pin is, however (with a vertical engine), made up of a vertical motion equal to the piston travel and an equal, horizontal motion, the two combined giving the movement in a circle, as above stated. It is therefore correct to say that, with a vertical engine, the up-and-down motion of the crank, or the vertical part or component of its motion, equals the motion of the piston, and in no other sense can their motions or distances traveled be said to be the same, and similarly with a horizontal engine for the horizontal component of the motion of the crank and the motion of the piston. The ratio between the actual distances traveled, the one in the circular and the other in the straight line path, is, of course, the ratio between the circumference of a circle and its diameter, or 3.1416—the ratio commonly represented by the Greek letter π (called *pi*).

The 1898 Blue Book of American Shipping has been received. It is one-fourth larger than the 1898 edition containing 575 pages, fully one-half of which are devoted to coast information. The selection and accuracy of this information could hardly be excelled were the book published exclusively for coast interests instead of the whole United States. It is really a complete marine directory of the United States, and any one connected in any way with maritime affairs will find it not only useful, but ornamental, as there are over 100 pages of illustrations of numerous coast and ocean steamers, 30 war ships and over 100 portraits of prominent eastern marine business men. One of the most important features is a list of over 6,000 coast and river steamers, including practically all coast vessels over 100 tons. Six thousand masters', mates' and engineers' names and addresses are included, as well as complete directories of the Society of Naval Architects and Marine Engineers, Society of Naval Engineers, the National Board of Steam Navigation, and a directory of departments of the U. S. Government with which marine men have business. There are lists of ship builders and a list of 500 concerns that own 3,000 of the better class of coast vessels. Statistical information of exports by port and commodity for six years past, and tables showing the condition of American shipping, are shown. Lists of 400 ship builders of the world and 1,280 owners of 10,000 of the largest vessels in the world are added. It is of practical use to steamship agents, owners, and everybody engaged in marine business, containing information that is constantly needed. It is published by the Marine Review, Cleveland, O., price $5.

SELECTED PATENTS.

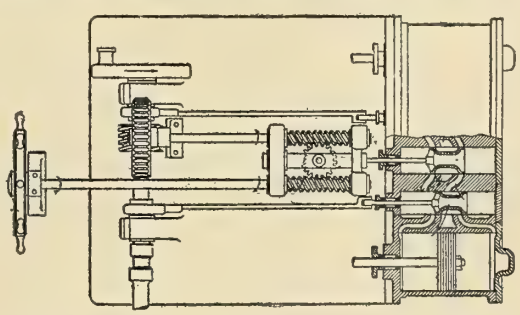
599,220. ELECTRIC-ALARM WATER-COLUMN. *Martin L. Bush, Lawrence, Mass., assignor of one-half to Charles F. Swain, Methuen, Mass. Filed June 14, 1897.*



The combination in an electric-alarm water-cylinder having boiler connections, of a float in the cylinder, a tube and rod connected with cylinder insulated from each other, and carrying arms adapted to be engaged by said float, means for vertically adjusting the arms, and the wires and battery connections whereby the alarm is sounded when the float contacts with the arms.

603,038. STEAM STEERING-GEAR. *William H. Harfield, London, England. Filed October 29, 1897. Patented in England March 22, 1889. No. 5,018.*

In a steam steering-gear, the combination with the engine-cylinder, piston and driving-shaft, of a valve-chamber provided with a steam-inlet and ports communicating with the cylinder on both sides of the piston, of a controlling and reversing valve normally closing the ports, a valve-rod connected to the valve and provided with a worm-wheel, a worm shaft operated by the steering-wheel and provided with a worm engaging the worm-wheel, and a worm-shaft operated by the engine-shaft provided with a worm engaging the worm-wheel for moving said valve back to its normal position. The combination with the engine-cylinder, of a controlling and reversing valve therefor, a valve-rod connected with the valve and provided with a worm-wheel, a worm operated by the steering-wheel, engaging the worm-wheel for moving the valve in either direction, and a worm driven by the engine, engaging the worm-wheel for moving the valve back into its initial position. The

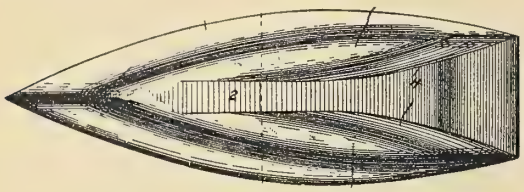


combination with the engine cylinder, piston and driving-shaft, of a controlling and reversing valve, a longitudinally-movally bar connected to the valve, the bar being mounted in stationary guides, and provided with a worm-wheel, a worm engaging the worm-wheel on one side, and operatively connected with the steering wheel, and a worm engaging the worm-wheel on the opposite side and operatively connected with the engine.

597,195. BOAT. *Martin V. B. Evesson, Aransas Pass, Tex. Filed May 28, 1896.*

As an improvement in boat construction, the hereindescribed hull, the same being grooved centrally along its bottom, from a point just abaft the stem, with the line of the groove gradually rising from said point

to the stern of the boat, thus forming upon each side of the central portion of the hull convex ridges tapering near their rear ends upon curved lines from near the longitudinal center of the hull end extending to



the stern and at a point near the stern inclining upward as they approach the stern, whereby the escape of the water is facilitated and giving greater stability to the boat.

No war, in recent years at any rate, afforded more subject matter for illustrations in technical and popular periodicals than the Spanish-American war. Some of this matter has, of course, been made use of without discrimination, but among popular papers the Navy and Army Illustrated, of London, has taken high place in the reproduction of accurate pictures of both sides. In views of naval ships, both Spanish and American, it has far surpassed its contemporaries, both in variety and in the very important point of accuracy, as most of the views presented were reproductions of actual photographs. We have, indeed, found upon occasion in its pages the only authentic views of various naval subjects and in several instances have reproduced these for the benefit of our readers. The paper is indeed a standard authority in matters pertaining to the British Navy and Army. The half-tone illustrations in each issue are the finest specimens of process work published in the United Kingdom. The paper is edited by Commander Charles N. Robinson, R. N., and is published by the enterprising George Newnes, 12 Southampton street, London, W. C. It is a weekly, and the foreign subscription is 34s. 8d. a year.

A "Master's Manual" for 1898 has been published by the Great Lakes Register, Royal Insurance building, Chicago. It is an exceedingly convenient compilation, including the various rules and regulations, both federal and local, for the navigation of lake waterways, detailed instructions on using the compass and the use of charts, laws affecting citizenship of officers, cases of wreck, the carriage of passengers, life-saving instructions and a chapter explanatory of the weather. This is illustrated with drawings of the various United States signal flags and of the Canadian storm signals. There are a number of sheets of memoranda paper at the back of the book, which contains about 120 pages.

TRADE PUBLICATIONS.

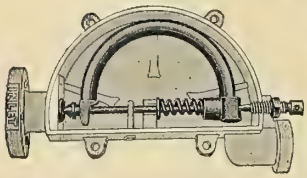
A 50-page catalogue of boats and canoes is received from C. B. Mather & Co., Rowley, Mass. It illustrates a full line of yacht tenders, rowboats, canoes, and, in short, almost everything in the line of small boats. Much valuable information is given which will be appreciated by every user of boats.

A very handsomely printed and completely illustrated catalogue of 80 pages, 6 by 9 in. in size, is issued by the Morse Twist Drill & Machine Co., New Bedford, Mass. It illustrates a full line of twist drills, chucks, reamers, milling cutters, taps and dies, and machine tools. A copy of this catalogue should be in the hands of every user of tools, as frequent reference is made to it in the advertisement of this company which appears in our advertising pages.

Live Steam

costs money. If wasted for want of a good steam trap—means just that much profit actually burned up in your boiler. Prevent it? Of course you can. Use the "Heintz" Steam Trap on all outlets; saves steam, allows no waste of hot water. You can take a "Heintz" on thirty days' trial—or buy one, use it a year and if not satisfied, return the trap—we return your money. Did we ever return it? No, never asked to; but it has been our guarantee, and we are always ready to meet it.

Booklet "G" will tell our story further, and we would like to send you a copy.



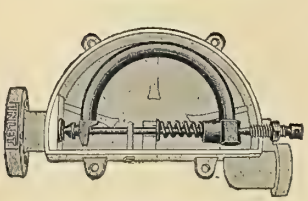
William S. Haines Company,
136 South Fourth Street,
Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 1

Hot Water

saved with the "Heintz" Steam Trap—puts it where you want it, too. Works in any position—opens and closes on difference of one degree of heat—211° to 212°—smallest size discharges one gallon water a minute and not an ounce of steam wasted. Six parts besides the case—No levers, no floats, no springs. Practically nothing to wear out. Ask for Booklet "G"



William S. Haines Company,
136 South Fourth Street,
Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 9

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

AN OPPORTUNITY FOR MARINE ENGINEERS.

AMERICAN SCHOOL OF CORRESPONDENCE
(Chartered by the Commonwealth of Massachusetts)
Offers a Thorough Course in

MARINE ENGINEERING.

We make a SPECIALTY of teaching Steam, Electrical and Mechanical Engineering.

Our COURSES are thorough and practical.

Our ADVISORY BOARD consists of experts of world-wide fame.

Our INSTRUCTORS are graduates of the best technical schools.

Our TERMS are low and within reach of every wage-earner.

Hundreds of ambitious ENGINEERS, ELECTRICIANS and MECHANICS have secured better positions and larger salaries through the up-to-date technical education received from our school.
We have helped others and we can help YOU.

Special Offer to Readers of "Marine Engineering."

33 1/3% REDUCTION. For another 30 days we will **FOR 30 DAYS.**

continue to offer **33 1/3% REDUCTION** from our regular tuition fee to all readers of MARINE ENGINEERING. Write for our new handbook "N" containing schedules of courses, names of instructors, pages from instruction papers, etc.

AMERICAN SCHOOL OF CORRESPONDENCE,
BOSTON, MASS.

An 8-page folder, descriptive of the Dart patent union coupling and of the patent self-lubricating ball or roller bearing iron cocks, is received. These goods are manufactured by the E. M. Dart Mfg. Co., Providence, R. I. Information regarding them and copies of the folder are sent to all inquiring for them.

Simple and compound engines manufactured by the Cruickshank Engine Co., Providence, R. I., are illustrated and described in a 4-page folder. These engines are built in any size from 3 horse power up, and their special features are well described in the folder.

A series of sheets, illustrating all the types of engines manufactured by W. D. Forbes & Co., Hoboken, N. J., is being issued, and should be in the hands of every man who has to do with engines for propelling purposes or for running electric plants, ventilating fans, etc. The sheets are 6 by 9 in. in size, and on the back of each is detailed description of the engines illustrated. The sheets are designed to form part of a permanent catalogue, which will not be bound, but contained in a strong folder, thus making them convenient for handling and for future reference.

BUSINESS NOTES.

PICTURE OF THE OREGON.—A handsome color picture of the battleship Oregon is sent to all engineers by The Peerless Rubber Mfg. Co., 16 Warren St., New York, upon receipt of five cents in stamps. It is large and suitable for framing.

AN IMMENSE MACHINE.—The Hilles & Jones Co., Wilmington, Del., has recently completed an immense machine for the Harlan & Hollingsworth Co., for rolling and bending ship plates. The machine was of such size that three cars were required to transport it.

ANTI-FOULING PAINT ON THE "FARRAGUT."—The torpedo-boat destroyer Farragut, recently given a test by the Union Iron Works, San Francisco, who built her, was painted with Williams' submarine compound after very exhaustive water tests made of this and other paints. This paint is made by Samuel J. Williams, Produce Exchange, New York.

A NEW POLICE BOAT.—The State of Massachusetts is about to put into commission the new state police boat, "Lexington," built at Essex, Mass., by A. D. Storey. She is 122 ft. long, and is equipped with compound engines of 700 horse power, built by Bertelsen & Peterson, East Boston, Mass., and boilers supplied by the Almy Water Tube Boiler Co., Providence, R. I.

ROD PACKING.—The diagonal rod packing illustrated and briefly described in the advertisement of C. A. Daniel, 409 Market St., Philadelphia, is particularly adapted for almost every use in marine work where packing is used. The cuts well illustrate the manner in which the packing is applied. Samples will be sent to all inquirers who wish to see the manner in which the packing is made.

THE DAIMLER PATENTS.—All the property, including plant, machinery, patents, etc., formerly belonging to the Daimler Motor Co., have been purchased by the Daimler Mfg. Co., Long Island City, N. Y. The business is so favorably known that the new company has already found it necessary to increase its facilities in order to supply the demand for boats and yachts of all kinds as well as for engines.

ASBESTOS AIR CELL FIRE BOARD.—The U. S. Navy is considering the adoption of asbestos air cell fire boards for bulkheads and other purposes on the new vessels to be ordered, for the reason that it is fire proof, water proof, sound proof, vermin proof, very light in weight, yet strong, and will prevent metal from sweating. It is particularly adapted to any use on board a vessel where any of these requirements are called for. Full information regarding this board can be had from the New York Asbestos Co., 287 Douglass St., Broklyn, N. Y.

Shipbuilding Company Incorporated.—Owing to a largely increased business, Captain R. M. Spedden, of Baltimore, has incorporated his shipbuilding business under the name of the Spedden Shipbuilding Co.

Forgings for Japan.—The Bethlehem Iron Co., South Bethlehem, Pa., has been asked to bid on the forgings for the engine and shafting for a torpedo-boat to be built in Japan for the Imperial Japanese Navy. The line of shafts, including the thrust and crank shafts, is to be hollow. It is understood that the Bethlehem Co. is the only concern in this country that has been asked to bid on this work.

Patent Stockless Anchors.—We are informed that the Baldt Anchor Co., Chester, Pa., has just accepted an order for 100,000 lbs. of anchors of their latest improved type for export, which is a high compliment to this company. The Baldt anchors have been approved by the Lloyds, thus giving them commercial standing, and the manufacturers are very busy now, having on hand domestic orders for over 100,000 lbs. of anchors ranging in weight from 20 to 12,000 lbs. These anchors are made of a fine quality of steel of 60,000 lbs. tensile strength, with an elongation of 15 per cent to 25 per cent in 8 in. This company has agencies in New York and in Cleveland, as shown in the advertisement.

Popular Devices.—In a letter to Marine Engineering, H. Bloomsburg & Co., Newport News, Va., say: "We are now furnishing circulators for four boilers and a jet for the donkey stock of a Merchants' & Miners' Transportation Co.'s ship, and have delivered circulators for two boilers for the Chemical Co.'s steamer, both building at Harlan & Hollinsworth Co., Wilmington, Del. We furnished one circulator to Cambell & Zell Co., Baltimore, for P. Dougherty's tug, and have an order from them for another for the tug Confidence for the Boston Towboat Co. We have just shipped one circulator for the steamer Flyer of Seattle, Wash. We have delivered two jets to the Hoboken Ferry Co., 45 in. by 71 in., for the steamers Hamburg and Bremen, and one 54 in. jet to the Neafie & Levy Co.

Howden Draft.—In a letter to the Detroit Dry Dock Co., Mr. A. W. Goodrich, of the Goodrich Transportation Co., wrote as follows regarding the results of the Howden hot draft system on the steamer Virginia: "Since it has been in use we have had steady steam, and burned slack coal, which costs us $1.10 per ton less than the coal we were forced to use before we introduced the Howden system. At the same time we applied the hot draft we also supplied the "Virginia" with new condensing apparatus, which gives a better vacuum than could be got before. Our saving in the price of coal has been 50 per cent. We attribute 33 1-3 per cent of the saving to the Howden system in enabling us to burn a cheaper grade of coal and maintain steady steam. The balance, or 16 2-3 per cent, we credit to the new condensers.

ZINC WHITE FOR MARINE INTERIORS.

In selecting a paint for the interior of a ship, three points require attention: Permanence of color, durability and brightness. Light is of great importance in a passenger steamer, hence light tints are commonly chosen. The permanence of this light color is of equal importance.

A French writer says: "For the painting of internal fittings of ships it is now universally admitted that zinc white is much more lasting than white lead; as the durability of interior painting is always in proportion to the quantity of oil absorbed."

Zinc white carries fully forty per cent of oil to the painted surface, white lead not more than fifteen per cent; the superiority of the former is obvious.

Moreover, zinc white remains unaltered in the presence of the sulphurous gases always present in ships, while all forms of lead rapidly darken in their presence. The tints produced with zinc white are also much more brilliant than those produced with lead, as any one can convince himself by making a sky-blue tint with zinc and Prussian blue, matching it as nearly as possible with white lead and Prussian blue, painting one half of a board with each, and exposing it to the sun-light and weather. The result will convince him that durable tints can be produced only with zinc white.—Adv.

New Jersey Zinc Co.

REDUCING VALVES

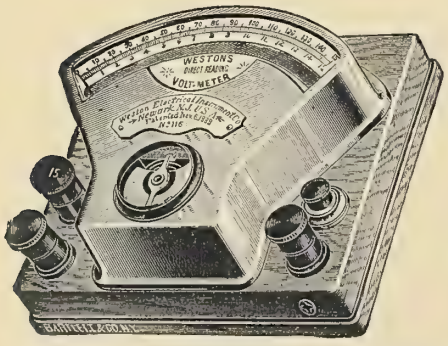
to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.



Weston Standard Portable Direct Reading Voltmeter.

WESTON STANDARD PORTABLE

DIRECT READING

VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Intruments are recognized as THE STANDARD the world over. Our VOLTMETERS and AMMETERS are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.,
114-120 William St., NEWARK, N. J., U. S. A.

WATERBURY BRASS COMPANY.—The friends of Theo. M. Baker, who has been connected with the copper and brass business for many years, will be interested to learn that he has made a connection with the Waterbury (Conn.) Brass Co. This company is one of the largest producers in the country of seamless brass and copper tubes, brazed tubes, and many other manufactures of brass and copper used in marine work.

BEACON LAMPS.—A recent writer says: "A few weeks ago we had occasion to call attention to the high-grade lamps turned out by the Beacon Lamp Company, New Brunswick, N. J., noting how they retain their initial candle power and high efficiency after a run of 300 hours. The standard efficiency of the lamps is 3.5 watts per candle, and it is an actual fact that after 300 hours' burning the lamps give more light and use less current than when started, and show no blackening."

INSTRUCTION BY CORRESPONDENCE.—Every ambitious engineer should investigate the methods for securing a thorough technical education in his chosen field as offered by the American School of Correspondence of Boston. The school devotes its entire attention to instruction in steam, electrical and mechanical engineering, the instructors in these special courses having been chosen from among the best technical schools of the country. They include such well-known authorities as Dr. Robert Grimshaw, George L. Fowler, Francis V. Boyer, Charles Thorn and other experts on the Advisory Board. The courses are thoroughly up to date and comprehensive; the instruction is simple, practical and scientific, and is so arranged that it can be worked out during leisure moments at home. The school is chartered by the Commonwealth of Massachusetts, and as it is a purely educational institution, and not a money-making enterprise, the tuition fee has been placed within reach of the poorest paid mechanic. The school has a large enrollment, and is endorsed by leading educators and engineers. Handbook will be sent on request.

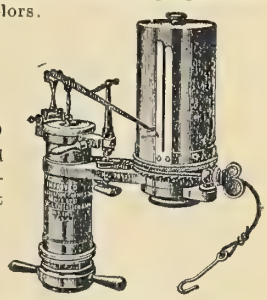
SEND 2 LABELS

cut from front of boxes of EUREKA PACKING and we will send you a pack of beautiful playing cards. All being special in 3 colors.

MARINE ENGINEERS

should own an INDICATOR and know how to use it. Send for circular and *special* prices. It will interest you.

Jas. L. Robertson & Son,
218 Fulton St., N. Y.



SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

BOAT BUILDER WANTED.

I have one of the best equipped boat building yards and plants in the country, for wooden and steel hulls, oil and steam engines; fine frontage on the Delaware river, convenient to Philadelphia; best kind of an opening for an experienced man who can command business. Address, with full particulars, Boat Builder, care of Marine Engineering.

PROFESSIONAL CARD.

H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.
Manufacturer of **Screw Propellers** for Usual and for Special Work.
The Allen Dense Air Ice Machine for Steam Vessels.
41 MAIDEN LANE, NEW YORK.

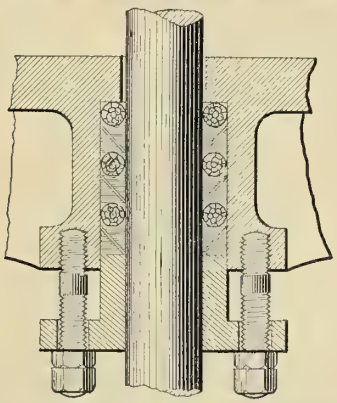


Fig. 1—Packing in position and gland adjusted

DANIEL'S PATENT P. P. P.

Diagonal Rod Packing.

The most elastic and durable packing for feed pumps, air pumps, hydraulic pumps, and trunk plunger pumps, also for electric engines and all other auxiliary engines and pumps. Special grades for high steam pressures on main engine rods and valve stems, also for ammonia compression pump rods.

Send for sample. Will not score the rods. Manufactured only by

C. A. DANIEL,

409 Market St., Philadelphia, Pa.

Branch Offices: Pittsburg, 105 Water St.; San Francisco, 514 Mission St.; Chicago, 4 S. Canal St.; Toledo, 638 Leonard St.

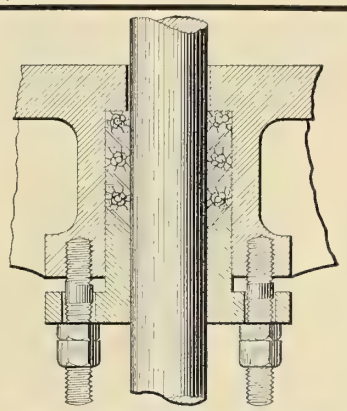
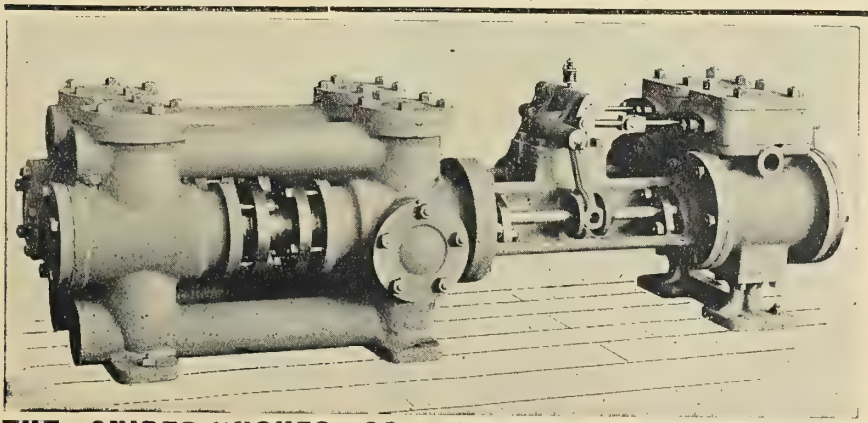


Fig. 2—Gland screwed down, showing how the wedges slide up to compensate for wear.



THE HUGHES IMPROVED DUPLEX PLUNGER PUMPS

Are extra strong, compact and durable. They are externally packed and are particularly well adapted for marine service. Catalogue showing different styles will be sent on application.

THE SNIDER-HUGHES CO., COE AND HAMILTON STREETS, CLEVELAND, O.

The Only AUTOMATIC Injector IN THE WORLD

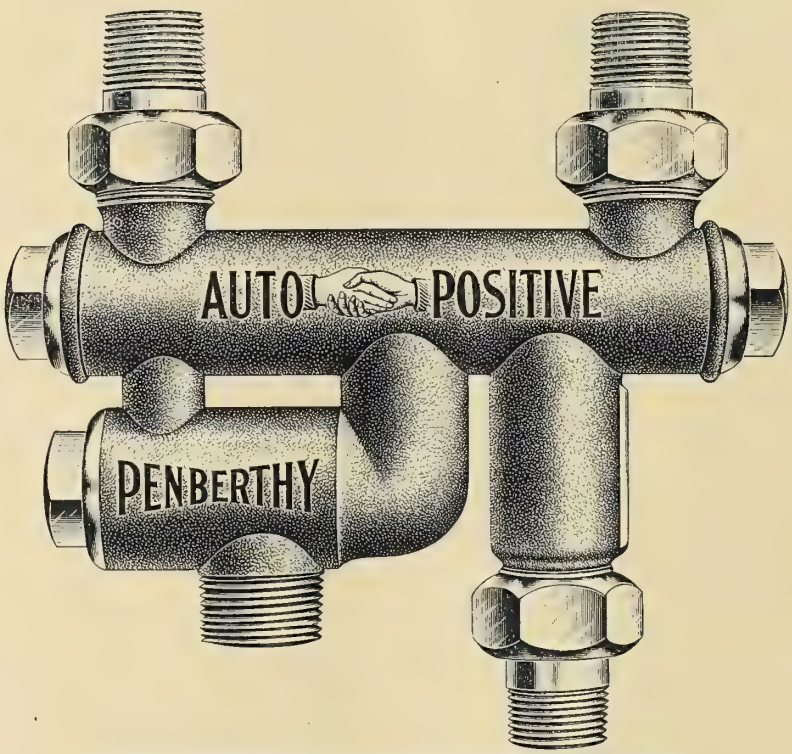
WHICH WILL START Low at 15 to 18 lbs. Steam,
Work High at 225 to 235 lbs. Steam,
Lift Water 20 to 22 ft., at 60 to 100 lbs. Steam,
Handle Hot Water at 140 to 143 degrees, at 75 to 100 lbs. Steam,

IS THE **AUTO - POSITIVE**

ONLY SIX WORKING PARTS

TRADE PENBERTHY MARK.

A MARVEL OF SIMPLICITY



HIGH PRESSURE AND HOT WATER INJECTOR.

AUTOMATIC IN ACTION.
POSITIVE IN RESULTS.

Especially Adapted for Marine and Water Tube Boilers.

PENBERTHY INJECTOR CO.

115 Seventh Street, Detroit, Mich.

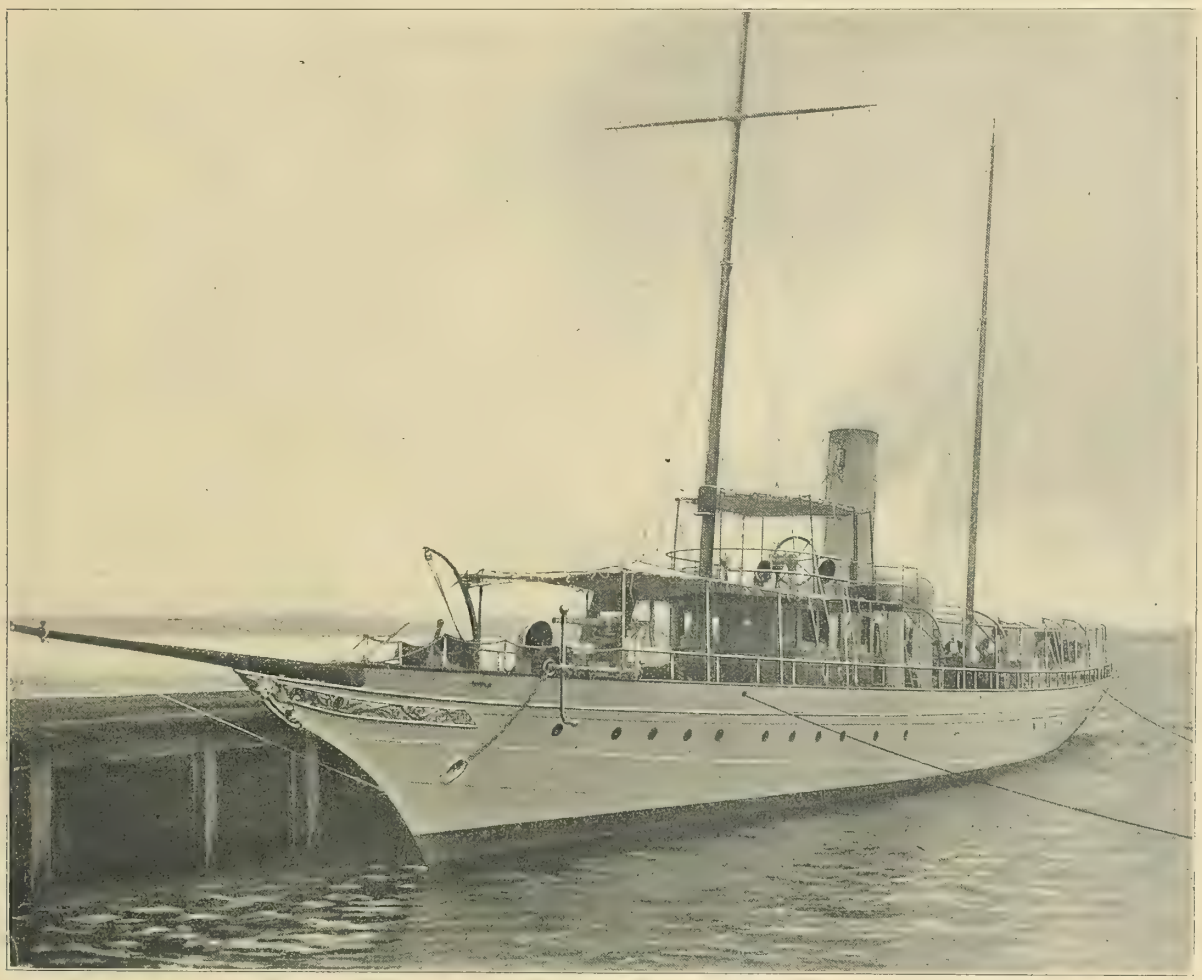
MARINE ENGINEERING.

Vol. 2. NEW YORK, OCTOBER, 1898. No. 10.

U. S. S. SYLPH, SELECTED BY THE NAVY DEPARTMENT AS THE PRESIDENT'S YACHT.

Our frontispiece shows the steel steam yacht Sylph which has been selected by the Navy Department as the official or President's yacht. She was designed by Gardner & Cox, of New York, and built by the Delaware River Iron Ship Building and Engine Works at Chester, Pa., this year. Her dimensions are: Extreme length, 152 ft.; beam, 20 ft.; depth, 10 ft. 6 in.; draught, 8 ft. 9 in.

This yacht was in an unfinished condition on the stocks at the time the Naval Board on auxiliary vessels was purchasing boats during the recent war. She was known as No. 295. The Board inspected the yacht and decided to purchase her on condition that a speed of 15 knots would be guaranteed. This was agreed to by the designers and builders, though she was designed for 14 knots only, and from private ownership the yacht was transferred to the Government. The change of use from a pleasure yacht to an auxiliary gunboat necessitated a number of



U.S.S. SYLPH, 159 TONS, THE PRESIDENT'S YACHT, LATELY AN AUXILIARY GUNBOAT.

Copyright, 1898, by The Marine Publishing Co., New York.

structural changes in the vessel, converting passenger accommodation into crew space and putting in magazines, etc. When the speed trials came off the guarantee given by the owners was more than realized, as the average for six hours over a course in the Delaware river was 16 knots, with 600 indicated horse power and a rate of coal consumption of but 1.6 lbs.

The Sylph is a single-screw boat with main engine of the vertical triple-expansion type. It is arranged with the H. P. cylinder forward, I. P. cylinder aft, and L. P. cylinder in the middle, the cranks being 120 deg. apart and following in this order: H. P., I. P. and L. P.—the cranks turning to starboard from the top center. The cylinders are lagged on the top and sides with asbestos and cased with Russia iron. The H. P. and I. P. cylinders have each one and the L. P. cylinder two piston valves. The valve gear is of the Stephenson link motion, with double-bar links. The engine was designed to develop 550 H. P. when running at 320 revolutions, with steam pressure of 225 lbs. per sq. in. in the boilers. The cylinders are supported by wrought steel columns, diagonally braced and resting on the bed plate. The guides for the crosshead slippers are of cast iron and are secured to the cylinders on top and to a longitudinal guide bar and the columns on the bottom. The crank shaft is hollow and in one section, of wrought steel. Air, circulating and feed pumps are all independent. The steam reversing cylinder is attached to the bed plate.

Some of the machinery dimensions are:

Cylinders, number	3
Cylinder, dia. H. P.	10 in.
Cylinder, dia. I. P.	16 in.
Cylinder, dia. L. P.	25 in.
Ratio net areas of pistons H. P. to L. P.	7.71
Ratio net areas of pistons H. P. to I. P.	3.16
Ratio net areas of pistons I. P. to L. P.	2.44
Stroke	16 in.
Valve, dia. H. P.	6 1-2 in.
Valve, dia. I. P.	10 1-2 in.
Valve, dia. L. P. (two)	10 in.
Piston rods, dia.	2 in.
Connecting rods, length center to center	38 in.
Crank shaft, length	8 ft. 5 in.
Crank shaft, dia.	5 in.
Crank pins, length	8 in.
Dia. axial hole	3 in.
Propeller shaft, length	35 ft. 3 in.
Thrust shaft, length	9 ft. 8 in.
Thrust shaft, dia.	5 in.
Thrust collars, number	6
Thrust collars, thickness	1 1-8 in.
Thrust collars, dia.	10 in.
Area of thrust surface	353 sq. in.

The circulating water is supplied by one centrifugal pump with runner 20 in. dia., and suction and discharge pipes 6 1-2 in. dia. There is one Davidson vertical, duplex air pump, with water cylinders 8 in. dia., steam cylinders 6 in. dia. and a stroke of 8 in.

There is one main feed pump and one auxiliary feed and bilge pump, both of the Worthington Admiralty pattern, with water cylinders 3 in. dia., steam cylinders 4 1-2 in. dia. and stroke 4 in.

Forced draft is supplied by a 42 in. fan, drawing air from the boiler room and delivering it into an air duct leading to the ash pits. The fan is driven by a single-cylinder engine, 6 in. by 3 in.

The electric outfit consists of a General Electric, direct-connected dynamo and engine, of 100 16-candle power light capacity, located in the engine room. The dynamo, which is of the quadrupolar type, is driven by a double cylinder, vertical, engine connected directly to the armature shaft. The sizes of cylinders are 4 in. dia. and 4 in. stroke.

There are two Almy water-tube boilers, placed alongside of each other in a water-tight fire room. They are fitted with double fronts and closed ash pits for forced draft. The boilers are so connected that they can be used together or worked independently. The grate surface for each boiler is 22 1-2 sq. ft. and the heating surface 750 sq. ft., making a total for both boilers of 42 sq. ft. grate surface and 1,700 sq. ft. heating surface. The working pressure allowed is 250 lbs. per sq. in. The outside dimensions over both boilers are 9 ft. 8 in. by 6 ft. 7 in., and the total weight with water, including all fittings, is 24,500 pounds.

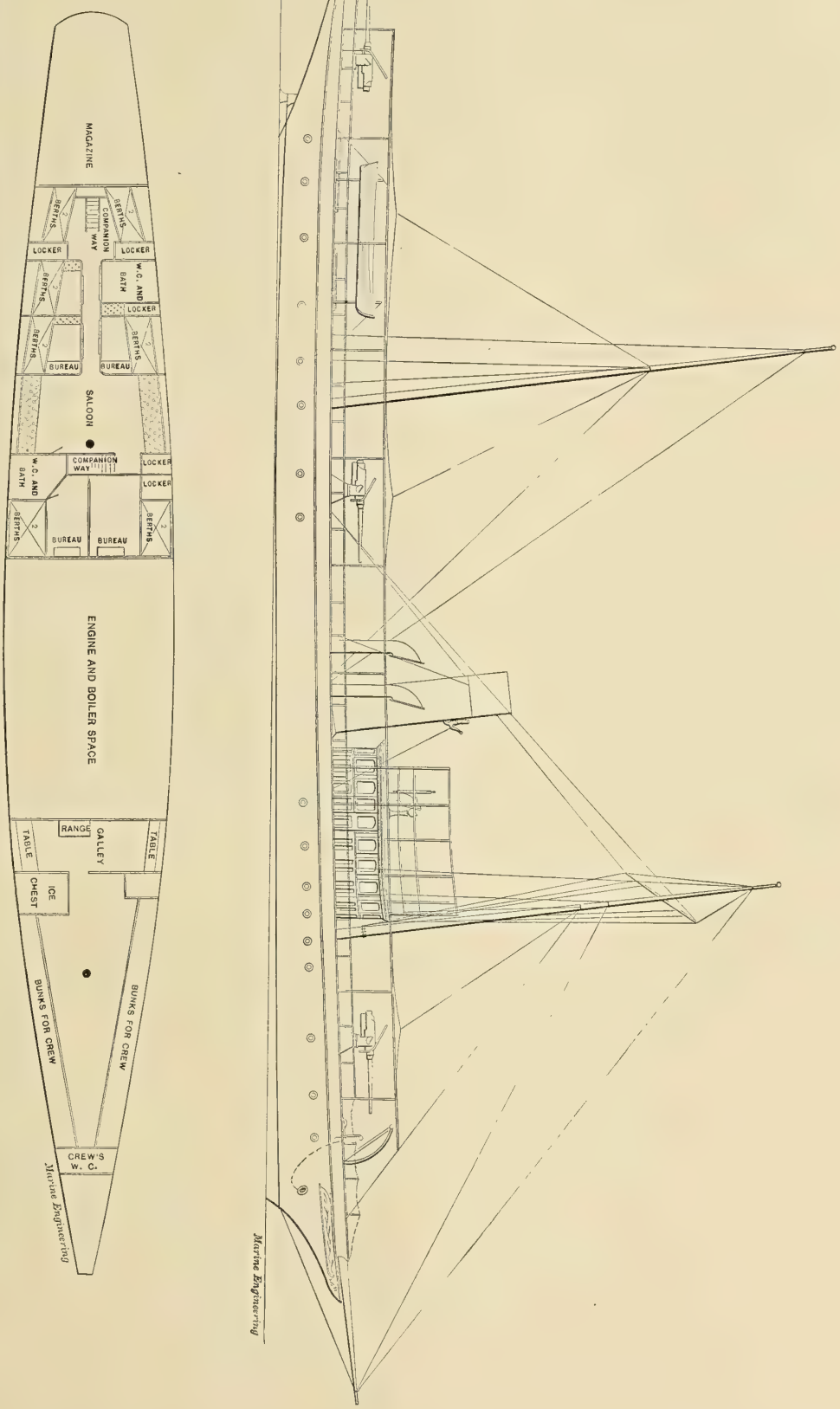
Particulars of the propeller, which is right-handed, three bladed and of steel, are here given:

Blades, number	3
Blades, dia.	6 ft. 3 in.
Hub, dia.	18 in.
Blades at root, thickness	2 1-2 in.
Helicoidal area	13.25 sq. ft.
Disc area	30.67 sq. ft.
Pitch	7 ft. 6 in.
Top of propeller, immersed	10 in.

Cast iron is used for the condenser shell which is cylindrical and fitted with bronze tube plates and ends. It is placed on the port side of the engine room and secured to the floors and frames of the hull. The circulating water passes through the tubes. The particulars are:

Tubes, number	663
Tubes, dia.	5-8 in.
Length between tube sheets	6 ft.
Cooling surface	650 sq. ft.
Ratio of cooling surface to H. S.	1:2.3

U. S. S. Sylph, as equipped for blockade duty, mounted a 6-pdr. bow chaser, two 3-pdr. broadside guns, and a 6-pdr. stern chaser. Her ammunition rooms were below the water line forward and aft, and protected further by water tanks. The official trial was made on the Delaware river off Deep Water Point in seven fathoms of water, and at top speed the wave and consequent change of trim due to bottom retardations was quite noticeable. The task was a difficult one, for both hull and machinery had been designed for a speed of 14 knots and now had to show over 15 knots for four hours. This



PROFILE AND ACCOMMODATION PLAN OF THE U. S. S. SYLPH—THE PRESIDENT'S YACHT—BUILT AT THE ROACH YARD, CHESTER, PA.

involved the burning of 40 lbs. of coal per sq. ft. of grate surface, and the increase of revolutions meant the development of 650 H. P. and a piston speed of 900 ft.; also putting heavy duty on all the auxiliaries. Everything worked out satisfactorily, however, and for five hours the boat was run at full speed, with an average mean, with and against tide, of 16.2 knots.

The Sylph as originally laid out was similar to the steam yacht Malay, designed by Gardner & Cox, and also built at Roach's yard this year for Dr. Charles G. Weld, of Boston, her dimensions, machinery, equipment, etc., being practically the same. When the examining board reported favorably on the boat she was plated and her deck laid and machinery put in place. To suit the altered conditions instead of a long central deck house, as on the S. Y. Malay, a forward house of mahogany was provided to be used as a dining saloon. This connects with the galley below. The officers' rooms forward were taken out and thrown into the forecastle to take care of the larger crew required. Below aft there are, as in the S. Y. Malay, four large state rooms, one of them the full width of the ship, all finished in white and gold, a large main saloon, and a double state room at the extreme after end; also two bath rooms with lavatories.

The Sylph is lighted throughout with electricity and provided with all the modern appliances suitable for a yacht of her type. Her coal capacity is 50 tons, and while primarily built as a cruiser her moderate draught would enable her to enter almost any of our ports. She will probably be largely used in carrying the President and his guests on short trips on the Potomac in the warm season. Her light draught makes her specially adapted to this use, and the fact that her deck house is limited in size will not interfere with the pleasure of those on board, her large space of open deck making a fine promenade.

The battleship Illinois will be launched from the yard of the Newport News Shipbuilding and Dry Dock Co. early this month. This vessel, which was authorized by the Act June 10, 1896, was laid down in February, 1897, and is under contract to be completed next September. She will be of about 11,500 tons displacement, and of the same general dimensions as the Kearsarge and Kentucky, launched from the same yard early this year. Her twin-screws will be driven by triple-expansion engines of 10,000 horse power, and a trial speed of 16 knots is expected. The batteries of this ship will differ very materially from those of the ships of the Indiana class. There will be four 13-in. rifles, mounted in two turrets, and fourteen 6-in. rapid-fire guns at the sides. There will also be extensive secondary and machine gun batteries and four long Whitehead torpedo tubes. The Harveyized armor protection ranges from 10 in. to 17 in. in thickness. The contract price for the Illinois is $2,595,000.

DISCUSSION OF THE MERITS OF TORPEDO CRAFT AND SOME OF THE FEATURES OF DESIGN AND CONSTRUCTION.—II.

BY WILLIAM A. FAIRBURN.

HINTS ON DESIGN IN GENERAL.

The machinery sometimes determines the depth of a boat, but the depth need not be sufficient to completely envelop the machinery, for there is no objection to a boiler casing or even an engine casing above deck. If the depth is small the scantlings of the vessel (or the material which contributes to the strength of the ship in fore and aft bending) will have to be heavier to obtain the same strength, but with a small depth, if one does not go to a ridiculous extreme, there is usually a net gain in weight of hull. The smaller the depth the more stability the boat will possess, for providing the center of gravity of the machinery is fixed, the center of gravity of the hull varies directly as the depth and the center of gravity of the armament and deck equipment, etc., is lowered, just as much as the depth is reduced. The coal capacity, if the depth is decreased, would be reduced somewhat, which is a bad feature; but its center of gravity would be lowered, the result being an increase of stability. Again, a deep boat necessitates large freeboard, and whilst this may contribute somewhat to sea-going qualities it has many great disadvantages, such as increase of target, the vessel being much more easily discernible at sea. When a torpedo-boat is designed for extreme speed, such as 30 or 31 knots on a displacement of 125 to 150 tons, it is essential that the depth be kept as small as possible, and a hog sheer used so as to reduce the weight of hull at the ends of the vessel. A hog-sheered boat, even when quite low forward, has proved in actual service to be an admirable sea boat, and she possesses great natural strength, with a neat, speedy, powerful appearance, provided the smokestacks and signal staff are worked plumb and not raked. The following table of depths for torpedo-boats will give, as a rule, good proportions for high speed, but the depth may vary in a design quite a little from these figures owing to peculiar requirements and conditions:

Displacement.	Depth.
150	10.6 ft.
200	11.0 "
250	12.0 "
300	13.0 "
400	14.0 "

The draught of the hull proper of torpedo-boat varies from about 3 ft. for a second-class coast defence boat to about 7 ft. for the largest destroyer. A suitable draught for a 150-ton torpedo-boat is about 4 ft. 6 in.; for a 250-ton destroyer, 5 ft. 6 in., and for a 350-ton destroyer, 6 ft. 6 in. There is a tendency in this country to make the model of torpedo-boats very fine, and some boats have been built with a block co-efficiency of much less than .4. Owing to the large ratio of length to beam such a "toothpick model"

is not essential for high speed, and a co-efficient of fineness of nearly .5 would give about as good a result as the finer form on a speed test in smooth water, and a very much better performance at sea.

The length of a torpedo-boat should be fixed by the length required by the machinery, plus the shortest length in which the complement can be berthed. After the preliminary figures are made and the power required to drive the proposed boat is decided upon, the machinery should be drawn in on the plan, making as compact an arrangement as possible. Berthing space for the crew must next be added on forward—some may be given berths and others hammocks so as to make this length as short as possible—and the accommodation for the officers and machinists is generally located aft, in such a fore and aft length that the center of gravity of the vessel will be in a suitable position in relation to the center of buoyancy.

It is impossible to design a torpedo-boat that will trim on an even keel in all conditions, but yet it is desirable to make the change of trim as small as possible and make the various water lines under the different conditions suitable for speed. The "Camel" arrangement of machinery, although it means a little added weight, due to increased length of shafting, etc., has many advantages. By this arrangement the engines are located in the center of the vessel, with a boiler room forward and another aft. If twin screws, the engines may be abreast of each other in a common compartment with the condensers aft of the main engine; but a separate watertight compartment for each engine, although it necessitates a greater length of machinery space, is considered preferable to-day. By this arrangement a coal bunker can be worked on one side of each engine room with direct communication to one of the fire rooms, provided that two boilers only are used, and these located at the extreme ends of the boiler compartments, the fire rooms adjoining the engine rooms. One great advantage of the "Camel" arrangement of machinery is its effect on change of trim for the various conditions from extreme light to extreme load. The writer knows of two torpedo-boats with exactly similar machinery, arranged in the usual manner in one vessel and "Camel" fashion in the other. Whereas the change of trim is 27 in. in the former it is only 9 in. in the latter.

There are only single and twin-screw torpedo vessels afloat to-day, but as the size of these vessels is constantly increasing, it will soon become essential to either build triple-screw destroyers or twin-screw vessels with four engines, i. e., two engines on each shaft. The latter arrangement has been used on the U. S. armored cruisers Brooklyn and New York, and it has many advantages. The length of the machinery spaces in torpedo-boats varies from about 40 to 50 per cent of the total length. For a first-class torpedo-boat 45 per cent of the vessel's length is a suitable length for the machinery, and for a destroyer about 50 per cent, although the writer is of the opinion that even these percentages could be increased with advantage by taking from the living spaces. By doing this, the weight of hull would be decreased, the boat made smaller, the cost greatly decreased, and the speed increased.

FRENCH TYPE OF TORPEDO-BOAT DESTROYER—ONE OF THE NEWEST AND FASTEST VESSELS.
(Reproduced from the Navy and Army Illustrated, London.)

NECESSARY COMPLEMENT

The complement or number of men required to man a sea-going torpedo-boat or destroyer varies from about one man for every five tons displacement to about one man for every six tons displacement. A torpedo-boat complement is not sufficient to run the vessel for any length of time at full speed with changing watches, but all the men on board are required to be at their stations when the order is given to steam at maximum power. Therefore a torpedo-boat could not keep up her maximum speed for any great length of time, for the complement would be physically unable to stand such a great stress.

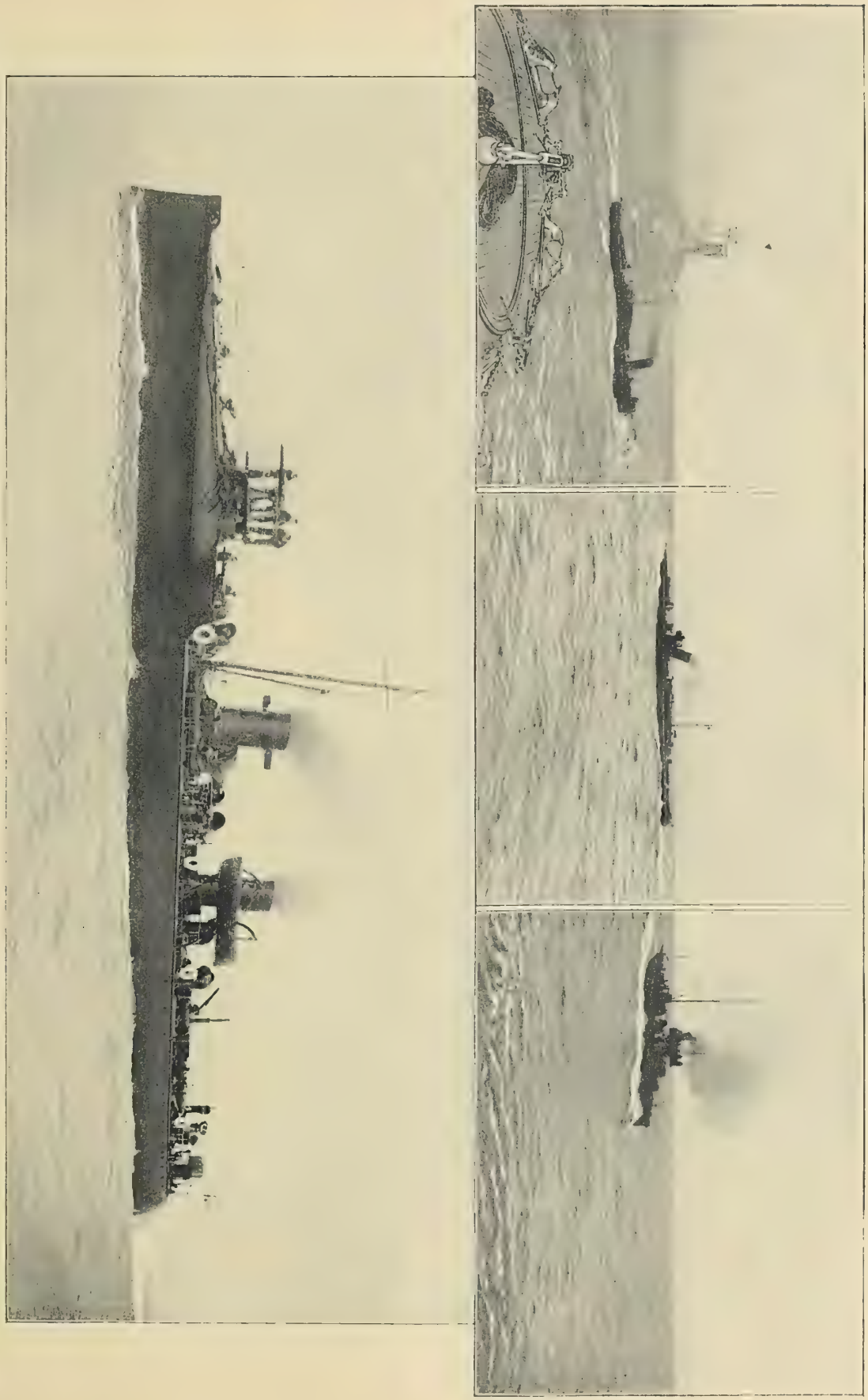
When estimating the complement necessary to man a torpedo-boat, it is desirable that there should be one man for every engine cylinder and one extra man for each engine room; two men for each furnace, and one extra man for each fire-room. The number of officers and the crew for working the guns and navigating the vessel is quite a variable quantity, for each Navy seems to have different ideas as to what is a sufficient number.

MATERIALS OF CONSTRUCTION.

The scantlings of a torpedo-boat must be made as light as possible, for the higher the speed the lighter must be the weight of the hull. Considerable science must be displayed if one is to correctly proportion the scantlings of a high-speed torpedo-boat. A merchant vessel of about 100 tons, built according to Lloyds' highest class, will have a stress of about only 1.5 tons when on a wave of her own length. An Atlantic liner, built according to the same requirements, will have a maximum stress of about 10 tons. These figures may not represent the actual stresses that come on the upper works per sq. in., but such figures are used as a standard means of comparison. In merchant work the same thickness of material must be allowed for corrosion, etc., on a small vessel as on a larger one. If an Atlantic liner has shell plates 1 in. thick, and of this 7-8 in. is necessary for strength and 1-8 in. for corrosion, the amount of metal fitted for the latter purpose is .125 of the total metal. But on a 100-ton boat if 1-16 in. is all that is necessary for strength, and to the same 1-8 in. is added for corrosion, the metal fitted for the latter purpose is .66 of the total steel that contributes to fore and aft strength. This explains why the scantlings of a small vessel are so much heavier than those of a large vessel in proportion to their size. In the design of torpedo-boats a margin cannot be added to the plating to allow for such matters as corrosion, grounding, banging against wharves, etc., for the scantlings must necessarily be made extremely light. Such boats must be well cared for in actual service, and it is desirable that they should be galvanized and kept in good water. The stresses allowed on torpedo-boats do not run as high, however, as in large merchant vessels, and whereas the latter may have a stress of say 10 tons, torpedo-boats do not go more than about 6 tons per sq. in. The assumption made when figuring this stress is the same in each case, viz.: a vessel poised on a wave of her own length and with a height equal to 1-20 of her length; but here, it must be remembered, there is quite a difference, for whereas small boats are constantly meeting with waves of their own length, which strain them to their maximum, large ships seldom, and sometimes, it may be, never meet waves of their own great length. Therefore it is desirable not only to consider stress, but the frequency with which the vessel may be expected to meet this maximum stress, and this being the case, we must provide a large margin on the small ships. High-grade steel should be used in the construction of all torpedo-boats, as this affords by far the best way of reducing the weight of the hull. Suppose a stress of 6 tons is all right for a steel hull built of material with a tensile strength of 30 tons, the factor of safety allowed here is 5.—elastic limit should be usually considered when dealing with factors of safety. If now a boat is designed with steel of 40 tons tensile strength one can allow, with the same factor of safety, for a stress of 8 tons, which will mean for the same strength a great reduction of weight. Nickel steel with a tensile strength of from 37 to 43 tons and with an elongation in 8 in. of from 17 to 13 per cent, is being used at the present time in Europe. It should be remembered that when high-grade steel of say 40 tons tensile strength is used in conjunction with ordinary steel of about 28 tons, there is no beneficial effect produced unless the high-grade steel is placed on each side of the neutral axis and as far from it as possible. If, as is now proposed in one of the new U. S. destroyer designs, 44-ton nickel steel is used on the deck and ordinary 28-ton steel at the keel and elsewhere, the lower part of the vessel will break in two when a certain stress is produced, and even if the top member of the girder does not break, what good can it do by remaining intact if the remainder of the vessel collapses? In torpedo-boats, as the heavy weight of the machinery and coal is concentrated amidships, the greatest stress will be in "sagging" or the keel in tension. The bending moment of such boats in the hollow of a wave—the worst condition—depends greatly on the space occupied by and the weight of the machinery, but it is usually about 1-20th of the product of the displacement and length in foot tons. Galvanizing by the usual hot process makes the material for torpedo-boats very unsatisfactory and hard to work, but galvanizing by the cold electric process gives excellent results and a much thinner layer of zinc.

DISPOSITION OF WEIGHTS.

When proportioning the scantlings of a torpedo-boat very great care should be given to the location of the neutral axis, for it is quite possible to add weight and yet make a weaker vessel. The scantlings of the boat should be greatly reduced at the ends of the vessel, and by just how much should be carefully figured out, for many excellent torpedo-boats to-day have the great fault of having their ends much too heavy. Much might be written on the methods of decreasing weights in the construction of torpedo-boats. Every pound of metal affects the final results. Flanging, for example, should be made to take the place of angle bar connections. Angle bulbs are greatly superior to angle bars even when fitted with reverse bars. The heavier the shell plates the further apart the frames should be located, and many builders to-day are greatly



GERMAN TORPEDO BOATS IN FLEET MANŒUVERS.

By courtesy of Corvetten-Capitain Hermann Gercke, Imperial German Navy.

BRITISH TORPEDO-BOAT DESTROYER BRUISER.

By courtesy of John Platt, M.E.

increasing the weight of the hull by spacing the frames much closer than is really necessary. The frames should be located so as to make the shell keep its shape, and the deck beams so close that the plates will not buckle between beams when the usual load is applied. Heavy scantlings will never reduce vibration, but it is essential that the hull be made rigid, and M. Normand has an admirable scheme of connecting the engine to the deck and engine foundation so that the vibratory forces are conveyed to the shell and deck plating. The usual method of estimating the weight of the hull of a torpedo-boat is to take a certain percentage of the displacement, but this is a very unsatisfactory way, as it takes no account of depth, fulness, or trial load carried. The most satisfactory way is to work out a co-efficient of the product of the principal dimensions, viz.: length, beam and depth for various known boats, and this co-efficient for similarly constructed vessels will be practically a constant.

Approx. weight of hull of a torpedo boat=.002 L. B. D.

Published weights or data should be multiplied by a "Human Co-efficient," and even if correct it is very difficult to determine just what is the weight of hull and what comes under the head of equipment and trial load. Even scaled weights of a hull are often deceiving, for they seldom if ever agree with the displacement scale when the boat is launched.

CONCERNING THE MACHINERY.

Now let us briefly consider the machinery. If we are searching for the greatest simplicity and minimum weight and cost a 3-cylinder triple-expansion engine is preferable to a 4-cylinder triple or quadruple-expansion engine. The maximum piston speed which it is considered desirable to run at to-day is about 1,200 ft. per min. A little longer stroke than is usually used, with a decreased number of turns, and the same piston speed would give splendid results. A 21 in. stroke for a 2,000 H. P. engine and a 24 in. stroke for a 3,500 H. P. engine the writer considers would be preferable to the usual 18 in. stroke and 400 revolutions. The latter figure seems to have been a standard for the engines of a destroyer. An increased stroke means, besides numerous minor advantages, a reduction in the inertia forces and a more durable engine. The mean effective pressure referred to the low-pressure cylinder on modern torpedo-boats varies all the way from 40 to 60 lbs., and the ratios of cylinder from about 4 to 7; a good average being 50 lbs., with a cylinder ratio of about 5.

The condensers in almost all cases are of the scoop form, the circulating water being driven through the tubes by the speed of the ship. The balancing of a torpedo-boat engine is a delicate problem, but having in mind general efficiency and a reduction of weight, the best results seem to be obtained with counterweights on tne cranks, the cylinders placed as close together as possible with the valves on the sides, and a diagonal tie on the engine to take the fore and aft couple This scheme orignated with M. Normand, and, as before mentioned, he transfers these vibratory forces, by means of this tie and the fastening of the engine, to the fore and aft metal of the hull, the deck and the shell, and therefore vibrations of the hull are hardly perceptible. There are so many different types of first-class small tube boilers suitable for torpedo-boats that it is impossible to tell which is the best all 'round torpedo-boat boiler. The Yarrow, Thornycroft and Normand boilers probably lead, as these three have successfully stood the test of many years. From 20 to 40 I. H. P. has been obtained per sq. ft. of grate area, the average being about 25 I. H. P. With steam jackets on the cylinders, efficient feed heaters and first-class firing, this figure has been increased to as high as 45 I. H. P. per sq. ft. of grate surface.

The coal consumption of modern torpedo-boats is usually about 2.5 lbs. per I. H. P. per hour at full power, and this figure drops down to about 1.5 to 1.7 lbs. at the economical cruising speed, usually 12 to 14 knots. The French torpedo-boat Forban had on her official 14 knot coal consumption trial a consumption of less than 1 lb. per I. H. P. per hour, but it must be remembered that the French use briquettes for fuel, and this may account somewhat for her remarkable economy. In the design of a torpedo-boat care should be taken in locating the coal bunkers, for in quite a number of boats afloat to-day there is great difficulty in feeding coal to the firerooms. Tie rods in fore and aft bunkers should be avoided as much as possible, for it is, even under the most favorable conditions, an extremely difficult job trimming and feeding coal in a torpedo-boat's wing bunkers.

POINTS ON PROPELLERS.

It has been found by experiment that an effective thrust of 12 lbs. or an indicated thrust of 20 lbs. per sq. in. of the propeller's projected blade area is the maximum thrust that a screw will develop with efficiency. This fact will determine the blade area of a propeller suitable for a proposed torpedo-boat, as the usual practice is to allow for an effective thrust very close to this maximum or between 10 and 12 lbs. per sq. in. After the blade area has been determined, it is a comparatively easy matter to determine the diameter and pitch of the wheel. Great care should be taken in giving the propeller suitable immersion and ample clearance to the hull, and even the fact of keeping the draught of the boat under the screws a minimum should be considered, but secondary to ample immersion and clearance. A screw for a sea-going torpedo vessel should have about 24 in. immersion, and should never be nearer to the hull than 15 in. Although unfortunately, this has been done on some recent boats in this country with disastrous results.

MACHINERY WEIGHTS.

The total weight of the machinery of torpedo-boats varies from about 45 to 75 lbs. per I. H. P. The best result obtained in our country up to the present time is about 50 lbs. per I. H. P. Some European boats go as low as 36 lbs., and some British 27 knot destroyers have machinery as heavy as 78 lbs. per I. H. P.

SPEED AND POWER.

Too much faith should not be put in the ordinary published data for speed and power of torpedo vessels. The displacement is in almost every case decidedly misleading, even if the indicated horse power and speed are stated approximately correct. In about 75 per cent of the designs for modern American torpedo-boats the power estimated on is much too low. It is a surprising fact that the larger the torpedo-boat the more difficult it is to obtain high speed. If the curve of the Admiralty propulsive co-efficient based on displacement is carefully studied it will be noticed that the value of this co-efficient is a minimum at the rising speed before mentioned as $9\sqrt[6]{\text{Disp.}}$ At this speed the boats commence to rise out of the water, and as the displacement becomes less the value of the coefficient $\frac{D^{\frac{2}{3}} \times \sqrt{\ }}{\text{I. H. P}}$ becomes greater. This gradual increase of efficiency will continue as the speed increases, with no further points of maximum or minimum values on the curve. The rising speed of a 125-ton torpedo-boat is about 20 knots, and a French boat of this displacement has steamed at 31 knots, the efficiency of propulsion gradually increasing for the last 11 knots. At low speeds the value of the Admiralty co-efficient is quite low, owing to the large and powerful machinery working at a very low power. There is therefore one maximum and one minimum in the curve of Admiralty co-efficients for every torpedo-boat. It follows, therefore, that no torpedo-boat should be designed to have a maximum speed within 2 knots on either side of the rising speed, but it will be noticed that the greatly increased size of destroyers is gradually bringing the maximum speed of these vessels to the point of minimum efficiency.

It is interesting to notice how the power of a torpedo vessel varies in relation to speed. A 400-ton destroyer will require over 8 times as much power at 30 knots as she will at 15 knots. A large first-class torpedo-boat requires about 2 1-2 times as much power to attain a speed of 20 knots as she needs for 15 knots, 4 1-2 times as much power for 25 knots, and about 7 times as much power for 30 knots. If at 15 knots an increase of speed of 1 knot means about 150 more I. H. P., an increase of 1 knot in the boat's speed at 30 knots will require about 400 I. H. P. On such a first-class sea-going boat the power required for a speed of 30 knots is just double that required for 23 knots.

TRIAL DIFFICULTIES.

High speed, with light hulls, quick running, light machinery and express water tube boilers is not as easy to obtain as some builders seem to think. Great care should be taken to have the design all right in the first place. When the boats are built and ready for trial, even if the design is first class in every respect, the builder's troubles commence. The firemen must be trained to work like so many machines, and it requires great skill and a strong constitution to fire these boilers, with grates as long as 9 or 10 ft. and a consumption of about 70 lbs. of coal per sq. ft. of grate per hour. Great skill must be displayed by the engineer who has charge of this "tuning up," and the way the trials are conducted is almost responsible for one half of the difficulty there is in obtaining this high speed.

SCARCITY OF PROPER MATERIAL.

Our torpedo-boat builders are experiencing great difficulty in obtaining some of the material which they need in the construction of these speedy vessels. The same thicknesses of high grade rolled and cast steel cannot be obtained in this country that are furnished every day by various European steeel makers, for some domestic steel makers at present refuse to furnish such material as is readily supplied abroad. They could do it if they but went to the expense of adapting their plants to this class of work. One would naturally expect some of our more enterprising firms to do this, as the demand at present seems to be fairly great and large enough to warrant an outlay for an increase of plant.

QUESTIONS OF COST.

Unless a shipbuilding firm has had some experience in the construction of torpedo-boats it is a very difficult matter to estimate the cost of the same, and the difficulty increases as the speed increases. The present tendency of American firms is to bid ridiculously low, and some of the prices are much lower than figures for the same class of work abroad. When many of the bidders on this class of work have encountered the difficulty of building and running the trial of these especially fast boats, their figures on proposed work will doubtless be much higher than they are at present. For a large 30-knot destroyer about $900 per ton of trial displacement and $1,100 per ton weight of hull and machinery is a fair price, while a first-class 30-knot torpedo-boat is worth about $1,100 and $1,300 respectively.

A large railroad transfer boat for use on the Mississippi at New Orleans was launched recently from the yard of the Iowa Iron Works at Dubuque. This ferry is 300 ft. long; 56 ft. beam, and when completed she will have four tracks with capacity for thirty-two loaded cars. This company built the torpedo boat Ericsson.

CHIEF CHARACTERISTICS OF BATTLESHIPS AND MONITORS PROVIDED FOR IN NAVAL SHIPBUILDING PROGRAMME OF 1898-99.

All the new ships for the navy provided for in the naval programme of 1898-99, under the Act of May 4, 1898, will soon be under construction at various private yards throughout the country. The programme includes three first-class battleships, four coast-defense monitors, twelve torpedo boats, and sixteen torpedo-boat destroyers. Bids for the battleships, torpedo boats and destroyers are now under consideration by the Navy Department, and probably by the time this appears in print the awards will have been made.

In previous issues we have given the chief characteristics of the torpedo boats and destroyers and the bids in detail. Here we propose to outline the leading features of design of the battleships and monitors.

The experiences gained during the recent naval operations were very opportune, for practical use will be made of them in the construction and equipment of all the new vessels. A notable example of this is in the demand of the Navy Department for increased speed of the battleships, though this had been for a considerable time urged by the Engineer-in-Chief, George W. Melville.

As originally specified the battleships were to be of 11,500 tons displacement and 15 to 16 knots speed, with a steaming radius of not less than 5,432 knots at 10 knots speed. The requirements were subsequently changed to vessels not to exceed 388 ft. in length of 12,500 tons displacement and 18 knots speed, with bunker capacity for

TABLE SHOWING THE BATTLESHIPS ORIGINALLY CALLED FOR BY DEPARTMENT AND THOSE WHICH WILL BE OBTAINED.

Particulars.	Original design.	Contractors' offer.
Speed, knots	16	18
Displacement, tons	11,500	12,500
Horse power	10,000	16,000
Coal on trial, tons	800	1,000
Coal, total tons	1,200	2,000
Radius of action, knots	5,400	10,000
Cost	$2,600,000	$2,890,000

2,000 tons of coal and a steaming radius of 10,000 miles at 10 knots. An exceedingly satisfactory feature of the amended type of ship is that it comes within the appropriation made by Congress for the slower (15 knot) vessels. The battleships are officially known as 10, 11 and 12, and are to be named the "Ohio," "Maine" and "Missouri."

For an improved type of battleship the following bids were received:

Newport News Shipbuilding and Dry Dock Co., Newport News, Va., submitted builders' plans for one 12,500-ton, 18-knot battleship, to be completed in 32 months, for $2,850,000. The Naval Board made some objections to the battery of this proposed ship, but received an assurance from the company that this would be arranged in accordance with the requirements of the Board.

Union Iron Works, San Francisco, one 12,200-ton, 18-knot battleship, to be completed in 32 months, for $2,899,000. This ship to be built according to the Department plans, except as to the propelling machinery and the length, this being increased to 388 ft., to get the additional displacement.

William Cramp & Sons Ship and Engine Building Co., Philadelphia, put in alternative bids; one for a 12,150-ton, 18-knot battleship, 384 ft. long, on Department plans except as to machinery, to be completed in 32 months, for $2,885,000. The other bid was for a vessel of 12,500 tons, 18 1-4 knots speed, to carry 2,000 tons of coal and have a radius of action of 10,000 knots.

In the original department designs for the battleships the propelling engines were of the vertical triple-expansion, four cylinder type. The boilers were single-ended Scotch designed for a working pressure of 210 pounds. The increase of displacement and speed decided upon will necessitate a revision of the machinery plans to get the increased power. Possibly three-cylinder engines may be adopted, and it is very probable that water-tube boilers will be used. In one case the Niclausse type is favored.

In points of design and equipment, other than the propelling machinery, the battleships as now proposed will be essentially the same as those originally drawn by the Bureau of Construction and Repair, under the supervision of its Chief, Commodore, Philip Hichborn.

The hull is to be of steel, not sheathed, with double bottom and close watertight subdivision. Two military masts will be fitted, and the usual outfit of boats. There will be a side armor belt of a maximum thickness of not less than 16 1-2 in. and a mean depth of 7 ft. 6 in. The belt is to extend at least from the stem to the after barbette and will be of maximum thickness through the engine and boiler spaces, and from thence forward will be tapered to a uniform thickness of 4 in. The transverse armor at the after end of the belt and that part forward of the boiler space will be 12 in. thick. The main barbettes will have armor 15 in. thick reduced to 10 in. in the rear. The turret armor will be 14 in. thick throughout. From the armor belt to the main deck the ship's side will be protected by a 5 1-2 in. steel armor from barbette to barbette, and coal will be carried back of a considerable portion of this armor. A protective deck will extend the entire length of the vessel, 2 3-4 in. thick on the flat with inclined sides 3 in. thick forward and 5 in. thick aft. A cellulose belt is to be worked along the sides the whole length of the ship. The conning tower will be 10 in. thick with an armored communication tube 7 in. thick, and there will also be an armored station aft with 6 in. protection. In the wake of the 6-in. guns on the main deck there is to be continuous armor 5 1-2 in. thick extending between the turerts, and additional protection will be afforded by 1 1-2 in. splinter bulkheads between the guns. The 6-in. guns on the upper deck will be protected by 5 1-2 in. armor and

1 1-2 in. splinter bulkheads. The small guns will be protected by shields and extra side plating.

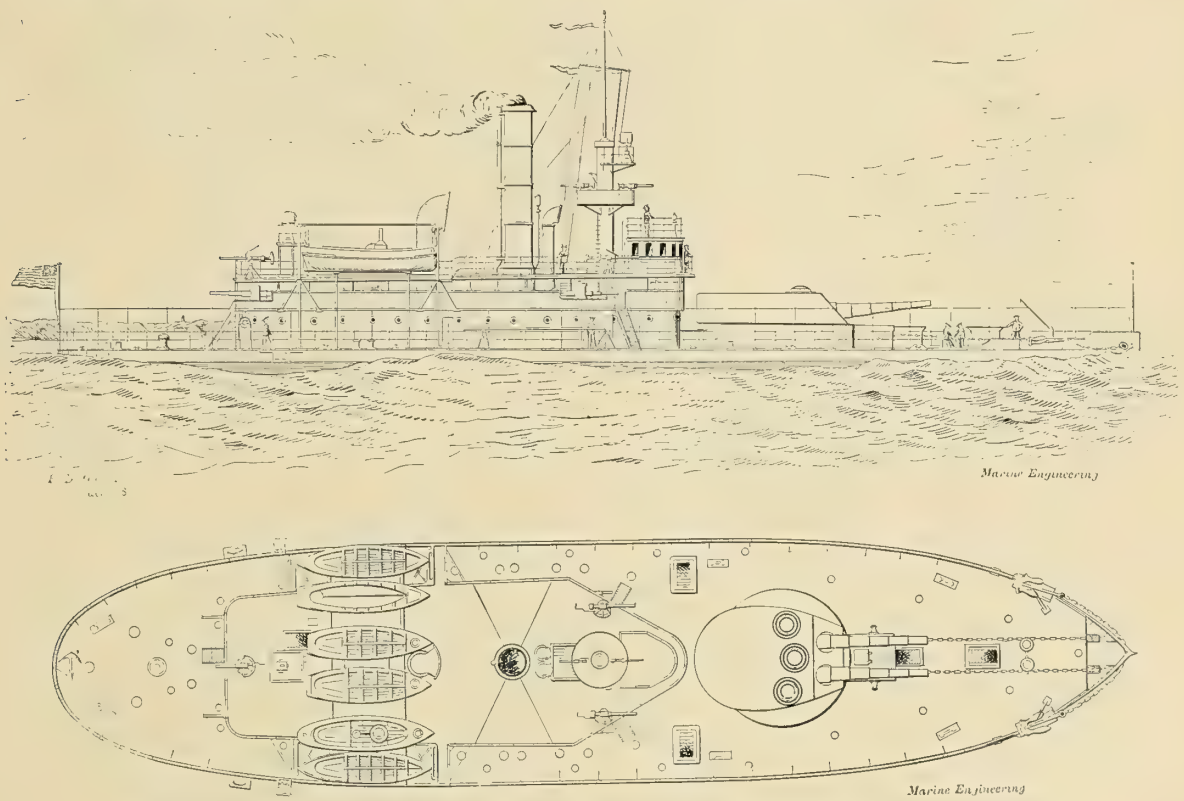
In addition to the main engines driving the twin screws there will be a most modern equipment of engine room auxiliaries and steam deck appliances.

The battery as outlined in the circular of the Department will consist of four 13-in. breech-loaders, two in each of the turrets on the mid-ship line; ten 6-in. rapid-fire guns broadside on the main deck and four on the upper deck within the superstructure, and a secondary battery of twenty-four rapid-fire and machine guns. The weight of guns and fittings is estimated as 574 tons, and the necessary ammunition 449 tons.

Harbor Defense Monitors.

The four harbor defense monitors called for in the Act of May 4, will present some of the most radical advances in modern fighting machinery. The monitor principle has always been distinctively American, and many experts regard the monitor as the best all around war ship yet designed.

The Act of Congress, appropriating for the naval service for the fiscal year ending June 30, 1899, under "Increase of the Navy," referring to the four harbor defense vessels of the monitor type, limits the cost of these vessels to $1,500,000 each. The limit of time of completion is twenty-seven months, with penalties for delay.



PROPOSED U.S. MONITORS ARKANSAS, CONNECTICUT, FLORIDA AND WYOMING.

Two submerged torpedo tubes will be fitted, and storage for eight 17 ft. torpedoes.

Electricity will be very extensively used on these ships. Not only will the turret turning gear be electrical, but also the ammunition hoists and the gear for training and loading the guns. Electric power will also be employed for driving ventilating fans and a variety of minor purposes. The generating plant will consist of eight units, each a direct connected set with an output of 400 amperes at 80 volts.

Provisions and small stores are to be carried for three months' supply and water allowance for fifteen days. Besides this an extensive distilling plant will be fitted. The complement of officers and crew will be 500 for each vessel.

The Navy Department, in the construction of this class of vessel securing the greatest results at the least expenditure of money, has in view not only the securing of the mainland harbors of the United States, but also of its island possessions in the Atlantic and Pacific oceans.

The design for the monitors, which have been named the "Arkansas," "Connecticut," "Florida," and "Wyoming," was prepared by Chief Constructor Hichborn. It was decided that the best all around arrangement that could be built with the available appropriation, was the arrangement with a single balanced turret on the center line forward, containing two high-powered 12 in. breech-loading rifles, a gun that has just been designed to be used with smokeless powder; four

4 in. rapid-fire rifles also to be used with smokeless powder, completes the main battery. The secondary battery will consist of three 6-pounder rapid-fire, and four, 1-pounder automatic rifles.

The general characteristics of these vessels as shown in the elements of design will be:

Length on load water line	225 feet
Breadth extreme at water line	50 "
Mean draft at normal displacement..	12 feet 6 inches
Normal displacement about.....	2,700 tons
Total coal capacity, loose stowage ..	200 "

In the details of design there will appear these characteristics.

The hull is to be of steel, not sheathed, with double bottom and close watertight sub-division.

There will be one military mast fitted with fighting and searchlight tops.

Seven boats are to be stowed clear of the blast of the guns, two being the lifeboats, which are to be carried at davits so as to be quickly lowered.

The protection of the hull against injury to the water line region is to be afforded by means of a side armor belt, the maximum thickness being 11 in., tapering to 5 in. at the armor shelf, the depth being 5 ft. The maximum thickness is abreast the engine and boiler spaces, from thence forward and aft it is reduced by steps to a minimum thickness of 5 in. at the bow and stern. The barbettes for the 12-in. guns will have armor about 10 in. thick.

The turret is of the Hichborn balanced type, with front plate inclined forty-two degrees from the vertical. The side plates of the turret armor are to be 9 in. thick. The main or protected deck is to extend throughout the length of the vessel, to be worked flat. The total thickness will be 1 1-2 in. A conning tower 7 1-2 in. thick having an armored communication tube 3 in. in thickness, will be carried in a suitable commanding position forward, the tube extending to the armor deck, and affording protection to the voice tubes, bell wires, etc.

Each vessel will be driven by twin screws. The engines (two in number) are to be of the vertical, triple-expansion type, in one watertight compartment. The high-pressure cylinder 17 in. dia., intermediate 26 1-4 in. dia., and the low-pressure 40 in. dia., with 24 in. stroke. The boilers (four in number) are to be of the water-tube type, constructed for a working pressure of 250 pounds, and are to be placed in one watertight compartment. There will be the usual auxiliary machinery and workshop tools.

Distilling apparatus and evaporators will be fitted for supplying fresh water.

The total coal bunker capacity will allow at least 200 tons with loose stowage, without trimming.

The total weight of machinery (but not including turret turning machinery, capstan, windlass, steering gear, or winches) is limited to 240 tons. Fifty tons of water for steaming purposes must be carried in the double bottom.

Steam windlass, steering engines and boat winches will be provided.

These vessels will have state rooms for the captain and for six officers, and will require a complement of crew of 125, for whom ample berthing space has been provided. Store rooms are provided for one month's supply of clothing, contingent and small stores.

The electric generating plant will consist of four units, each unit to have an engine, dynamo, and compensation bed plate, and each dynamo a rated output of 400 amperes at 80 volts.

The turret turning gear, ammunition hoists, elevating gear, rammers and ventilating apparatus, will be operated by electricity.

The estimated speed of the vessel is to be 12 knots—amply sufficient for a harbor defense vessel.

All wood used in the construction of the vessels will be fire proofed. The vessels will be fitted with docking keels, which will also serve the purpose of bilge keels.

These harbor defense monitors, which will have all the latest improvements known to naval science, will be important additions to the Navy, and being small, with large accommodations for crew for vessels of their size, they will be invaluable for the use and instruction of the naval militia. On October 1 bids for the construction of these monitors will be opened at the Navy Department, in Washington.

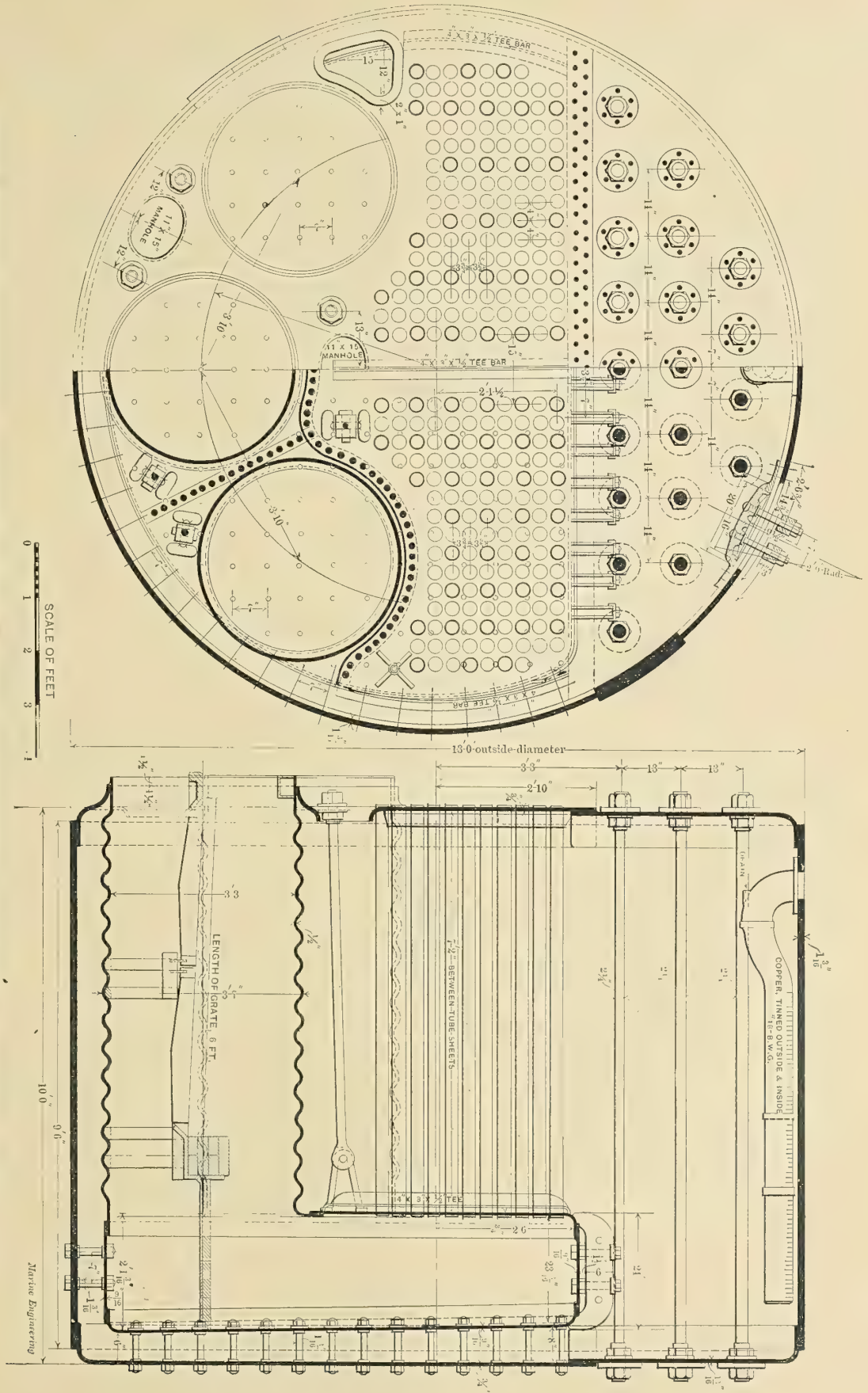
MACHINERY FOR THE NEW REVENUE CUTTER TO BE STATIONED AT NEW YORK.

A fine addition to the fleet of the Revenue Cutter service on the Atlantic coast will be made when the vessel now building at the Columbian Iron Works and Dry Dock Co., at Baltimore, is completed. This boat is officially known as No. 6, and is to be stationed at New York.

Her general dimensions are: length, over all, 188 ft.; between perpendiculars, 170 ft.; beam, molded, 29 ft.; and depth from base line at side amidship, 16 ft. 6 in. The displacement on 10 ft. draught is estimated at 706 tons. She is of very trim design, with high forecastle and poop, and is fitted with two masts schooner rig, and one smoke pipe, all of which have a slight rake.

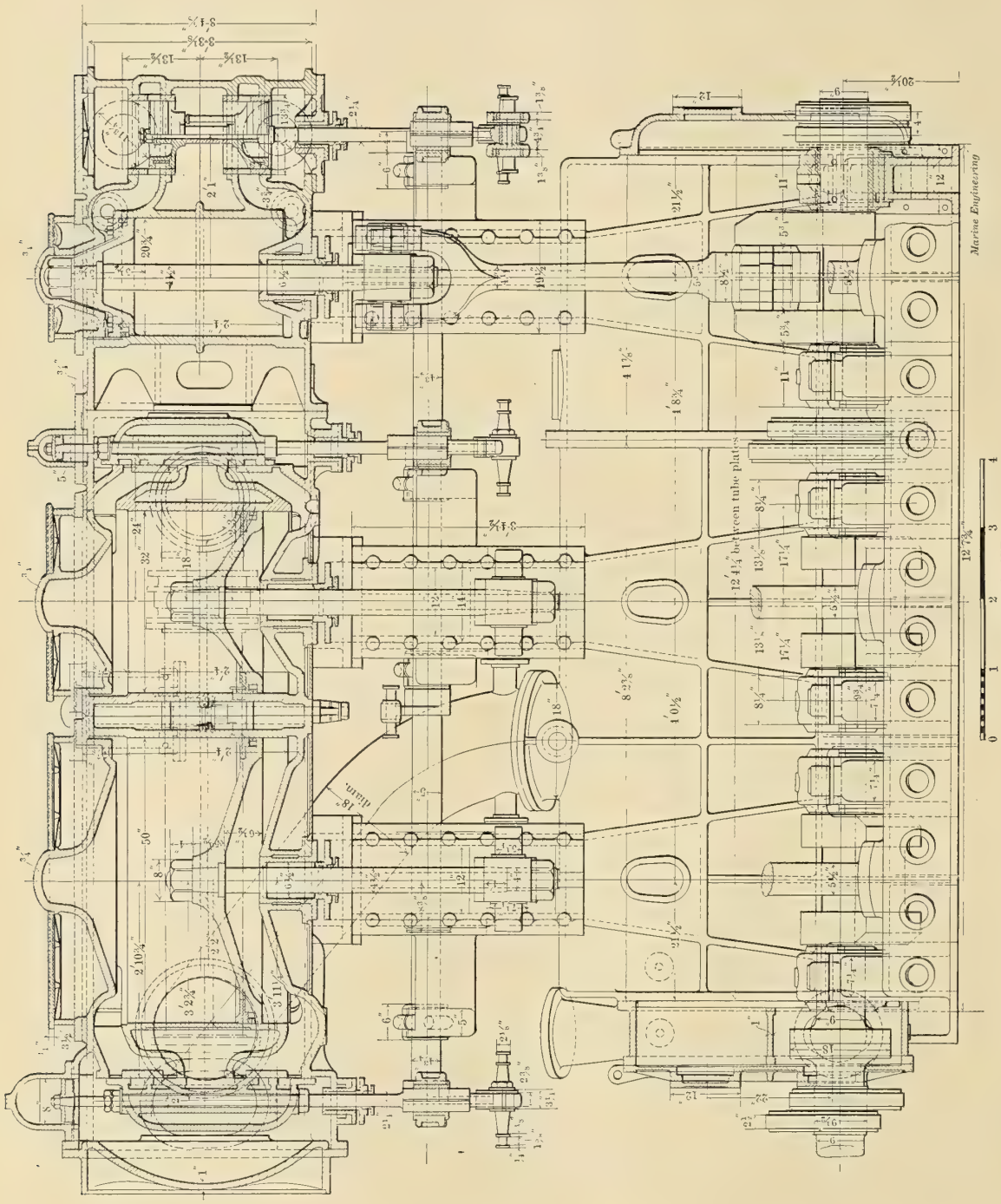
The accompanying illustrations show the designs of the engines and boilers of this vessel. These were drawn in the steam engineering bureau of the service at Washington under the supervision of Captain John W. Collins, Engineer-in-Chief of the Revenue Cutter Service. The engine is of the inverted triple-expansion type, designed for 1,500 I. H. P. The cylinders are 20 3-4 in., 32 in. and 50 in. dia. and 27 in. stroke. Piston valves are used for the high pressure cylinder and double ported slide valves for the intermediate and low pressure cylinders, all valves being worked by double bar Stephenson link motion. The engine framing consists of cast iron columns at the back

THREE FURNACE SINGLE-ENDED FIRE-TUBE BOILERS FOR NEW REVENUE CUTTER DESIGNED BY ENGINEER DEPT. U.S.R.C.S.



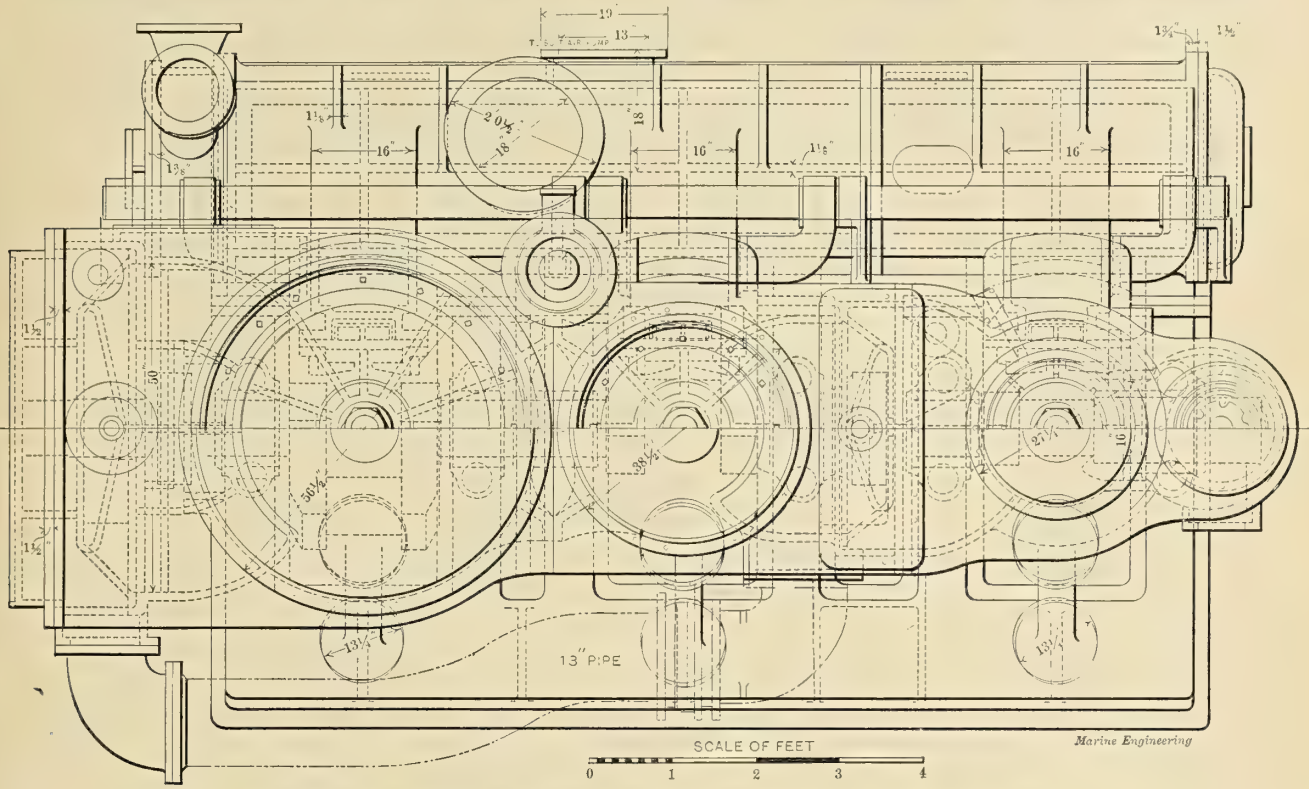
carrying single slippers, and wrought steel turned columns in front. The back columns are cast on the main condenser, this forming part of the framing. The bed plate is cast iron. The crank, line and propeller shafts are forged mild open-hearth steel, and are solid, and the piston rods, connecting rods and other working parts are of forged high-tensile open-hearth steel. All stuffing boxes will be packed with Katzenstein's metallic packing.

Some of the details of design of interest follow: Cylinder clearances, 3-8 in. between upper heads and pistons, and 1-2 in. between lower heads and pistons. High pressure valve: steam lap, top, 1 3-8 in., bottom, 1 3-16 in.; exhaust lap, top, minus 3-8 in.; bottom, zero. Intermediate slide valve: steam lap, top, 1 15-16 in., bottom, 1 1-16 in.; exhaust lap, top, minus 3-16 in. bottom plus 3-16 in. Low pressure slide valve: steam lap, top, 1 27-64 in., bottom, 1 15-64 in.; exhaust lap,

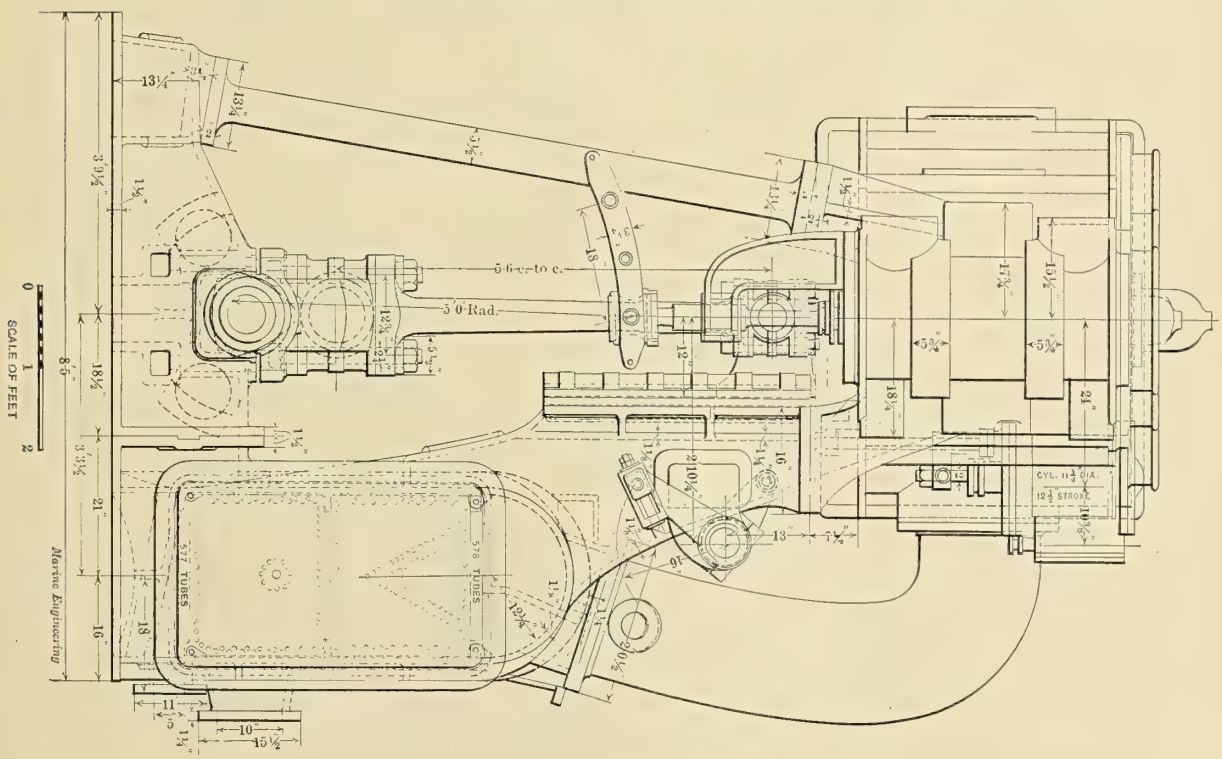


TRIPLE-EXPANSION ENGINE FOR NEW REVENUE CUTTER TO BE STATIONED AT NEW YORK.

top, plus 9-32 in., bottom, plus 19-32 in. Eccentrics of cast iron, the I. P. and L. P. in two parts and the H. P. solid. The reversing gear will consist of a steam cylinder 11 1-4 in. dia. and 12 1-2 in. stroke, placed vertically, and secured to the I. P. and L. P. cylinders. All journals will run in composition boxes, lined with Parson's white metal. The crankshaft is in two sections, with



PLAN OF TRIPLE-EXPANSION ENGINE FOR NEW REVENUE CUTTER.



END ELEVATION HIGH-PRESSURE CYLINDER.

cranks set 120 deg. apart. In the bearings the journals measure 9 in. dia. and 11 in. long, and the pins 9 in. dia. and 11 1-2 in. long. The webs are 11 1-2 in. wide and 5 3-4 in. thick, chamfered at the pin ends.

The thrust shaft is 9 in. dia., with nine collars 1 11-16 in. wide, with spaces 3 3-8 in. The collars are 14 1-2 in. outside dia. The intermediate shaft will be 9 in. dia. and the propeller shaft 9 1-2 in. dia.

The main engine condenser is rectangular in shape, cylindrical at the top and sloping at the bottom, and is made of cast iron 1 1-8 in. thick. The dimensions are about 12 ft. 4 1-4 in. between tube sheets, 2 ft. 0 1-2 in. wide, and 5 ft. high—inside measurements. The tube sheets are of composition 7-8 in. thick, and there are in all 1,155 Muntz metal tubes 5-8 in. O. D. tinned inside and out. The tubes are spaced 15-16 in. between centers. The total cooling surface is about 2,343 sq. ft.

Manganese bronze is used for the screw propeller, which is right handed with four blades, in dia. 9 ft. 6 in.

Two single-ended Scotch boilers will be fitted. These are 13 ft. outside dia. and 10 ft. long, over all, and are designed for 160 pounds pressure. They will be placed in a watertight compartment in one fire room. Each boiler has three corrugated furnaces 3 ft. 3 in. inside dia. The total heating surface is 3,392 sq. ft. and grate surface 112 sq. ft.

Besides steam for the main engine these boilers will supply the independent air pump and other auxiliaries. These will include a James Reilly distilling apparatus with a capacity of about 3,500 gallons of potable water in 24 hours. A centrifugal circulating pump with engine having an 8 in. by 8 in. steam cylinder will be fitted. The duplex feed pump will have steam cylinders 8 in. dia., water cylinders 5 in. dia. and 12 in. stroke. An auxiliary feed pump, a bilge pump, a distiller pump, an air compressing pump for the sanitary system, and a distiller circulating pump will also be included. A bilge ejector will have a 3 1-2 in. discharge. Other apparatus will comprise an ash ejector and machine tools in a small engineer's workshop.

There will be arrangements for the use of forced draft, on closed fire room system, for use in case of necessity. A direct acting engine will drive the blower.

Work on the vessel is well advanced, and she is expected to go into commission this year.

The welcome announcement that the Maryland Steel Co. would resume work in the Sparrows Point Shipyard was made last month. Work will be started with the construction of the torpedo boat destroyers which have been successfully bid on. This plant, as many of our readers are aware, is one of the most complete and best equipped in the country. Andrew G. Wilson is general superintendent.

REPORT UPON THE CONDITION OF ADMIRAL CERVERA'S VESSELS.

AFTER AN EXAMINATION BY A BOARD OF UNITED STATES NAVAL OFFICERS.

Special Attention Given to the Effects of Our Gun Fire, of Combustible Material, and Explosions—Sketches Showing Number and Location of Hits—Conclusions Drawn by the Board.

Soon after the naval fight at Santiago July 3, which resulted in the destruction of the Spanish vessels under command of Admiral Cervera, a board of U. S. naval officers was appointed by Admiral Sampson to inspect the three ships which were beached and burned. (Infanta Maria Teresa, Almirante Oquendo and Vizcaya), and also the sunken vessel Cristobal Colon. The members of the board were: Lieutenant Commander R. P. Rogers, Lieutenant Commander N. E. Mason, Lieutenant R. F. Nicholson, P. A. Engineer G. W. McElroy, P. A. Engineer F. M. Bennett, Lieutenant F. J. Haeseler, Lieutenant E. E. Capehart, Asist. Naval Con. R. P. Hobson.

They were instructed to report especially upon the effects of gun fire, of combustible material and explosions and also upon the feasibility of raising and saving the Cristobal Colon. The board immediately began a survey of what remained of the once splendid warships, which were lying at intervals on the Cuban shore west of Santiago; the farthest, the Cristobal Colon, lying at Rio Tourquino, a distance of 48 miles.

We here publish the intensely interesting report in full. Immediate note may be made of the general conclusions reached by the naval experts which are as follows:

The ships Infanta Maria Teresa, Almirante Oquendo and Vizcaya were destroyed by conflagration, caused by explosions of shells in the interior and setting fire to the woodwork. The upper decks, and all other woodwork, are entirely consumed, except at the extremities.

Many of the guns on board the burned ships were found loaded at the time of the Board's visit, indicating the haste with which the crews were driven from their guns.

The conclusions drawn by the Board from its examination of the captured Spanish ships are:

That the use of wood in the construction and equipment of warships should be reduced to the utmost minimum possible.

That loaded torpedoes above the water line are a serious menace to the vessel carrying them and that they should not be so carried by vessels other than torpedo boats.

That the value of rapid-fire batteries cannot be too highly estimated.

That all water and steam piping should be led beneath the protective deck or below the water line and fitted with risers at such points as may be considered necessary.

In the sketches which accompany the report, the approximate number and size of shot holes in the vessels are graphically displayed, and the location of the vessels, the Cristobal Colon

and Infanta Maria Teresa, on the beach are also shown.

The members of the Board express their indebtedness to Captain L. W. T. Waller, U. S. Marine Corps, for the photographs of the vessels which now form part of the report. Captain Waller served with distinction on the battleship Indiana during the Santiago engagement, and as soon as conditions on the wrecked vessels made it possible he went aboard and took a large number of photographs, showing in detail the awful destruction caused by our hits and the subsequent fires and explosions. Through the courtesy of Captain Waller we are able to here reproduce a number of the most striking of these now historic views.

To facilitate the ready application of the report to purposes of analysis we have prepared the tables here printed showing both the number

APPROXIMATE NUMBER OF SHOTS WHICH TOOK EFFECT ON THE SPANISH VESSELS IN THE SANTIAGO FIGHT.*

Spanish Warships.	Size of U. S. Guns.									
	13-inch.	12-inch.	8-inch.	6-inch.	5-inch.	4-inch.	6-pdr.	3-pdr.	1-pdr.	Total.
Viscaya	....	....	5	....	6	4	13	....		28
Oquendo	....	1	4	5	2	7	44	...	....	63
Teresa	....	2	3	....	4	1	16	....	1	27
Colon	....	....	....	....	3	....	4	....	....	7
Total	...	3	12	5	15	12	77	....	1	125

*Not including the shells which sunk the torpedo-boat destroyers Pluton and Furor.

SHOTS FIRED BY U. S. SHIPS DURING THE NAVAL ENGAGEMENT AT SANTIAGO, JULY 3, 1898.

U. S. Ships.	Size of Guns.									
	13-inch.	12-inch.	8-inch.	6-inch.	5-inch.	4-inch.	6-pdr.	3-pdr.	1-pdr.	Total.
Oregon	36	....	145	..	....	....	1500	....	....	1681
Iowa	....	31	35	....	....	251	1056	....	100	1473
Brooklyn	....	....	100	....	473	....	1200	....	200	1973
Gloucester	....	....	....	....	....	....	589	780	....	1369
Texas, Indiana	11	8	31	171	....	....	2208	....	....	2429
Totals	47	39	311	171	473	251	6553	780	300	8925

of shots fired by the U. S. vessels named and the approximate number of hits, as ascertained by the Board and by independent experts.

REPORT OF THE BOARD.

Following is the complete report of the Board of examination in the original text:

Infanta Maria Teresa.

CONDITION OF HULL.

Condition of Flotation—The vessel is nearly upright, laying without appreciable angle of keel, at a watering line differing from the L. W. L. by trimming about five feet by the stern. Flooding is practically complete, fore and aft, and may have been brought about by water entering above the protective deck through the stern torpedo tubes, and the broken joints of the waist torpedo tube castings. This is indicated by the swash in the present condition of the vessel. The vessel rests easily, bearing upon the bottom throughout the greater part of her length. Soundings show the bottom to be firm coral sand, shelving gently more or less, as indicated in the sketch here printed. (Page 18.)

Structural Solidity—The examination extended inside to the portion above protective deck, and included the outside complete, excepting the portion resting on the bottom. Diving between the hull was impracticable under the conditions.

Skeleton Frames—The frames above water are practically intact, having only deformation more or less moderate due to heat. They are doubtless intact below water, there being no evidence of bulging. For purposes of solidity they may be considered practically intact.

Deck Beams—The deck beams above water are generally more or less warped by the heat. The warping is more or less pronounced in portions where the wood flat had no metal flat below, notably on the main or upper deck and on the gun deck forward and abaft the engine and boiler spaces. In cases of supporting local weights, as windlasses, etc., the deformations were pronounced. The beams have sagged and dropped to such an extent as to destroy their structural usefulness. The stanchions have been affected in practically the same manner as the beams; warping being more pronounced in the 'tween decks, between the upper and gun deck. Generally speaking the fastenings of the beam arms are sound. Below the protective deck the deck beams are doubtless intact.

Bulkheads—The bulkheads above the protective deck were principally of wood and played but slight structural role in the normal condition. Those of metal—limiting the upper coal bunkers—are badly warped. Below the protective deck the bulkheading, longitudinal and transverse, is doubtless intact.

COVERINGS.

Outside Coverings—Generally speaking, the outside plating for structural purposes may be considered intact. There is warping, though not pronounced, in the upper portions subjected to heat. Divers' reports show an intact condition below the water as far as the examination could be extended. The portion resting on the bottom, extending over the greater part of the length below the bilges, except at the ends, could not be examined; but taking account of the extended evenness of the bearing surface, there is probably little deformation, and without appreciable injury to solidity.

Deck Plating—All deck plating above the protective deck, including the stringers and tie-plates, have been more or less warped and the fastenings impaired by the heat from the burning of the wooden deck-flat. Excepting the usual junction of stringer and tie plates, the deck plating above the protective deck is but slightly developed, and plays but small part of structural solidity in the normal condition.

In sum, taking full account of the distribution of the weights and the strains involved, and taking full account of the reduction of strength, as pointed out, it is considered that with an intact condition of internal structure below the protective deck, the remaining structural solidity is adequate for the stresses liable to be encountered in wrecking the vessel and those liable to be encountered in any except severe conditions of navigation. Occasion may be taken to point out that the vessel has suffered more as a longitudinal girder than a transverse girder, and that in a heavy sea it would be on the side of security to avoid the position of steaming head to sea.

It should be pointed out that, on account of the local weaknesses entailed by warping as described above, it would be on the side of security to remove the heavy guns and turrets and the conning tower before the vessel be sent to sea.

Effect of Internal Explosions—There are no indications of any internal explosions having occurred on this vessel. All deformations found can be accounted for by the heat effect of conflagration.

CONDITION OF ORDNANCE EQUIPMENTS, ETC.

The 11-inch guns and mounts are in an excellent condition, requiring only such care as is necessary to protect them from the injurious effects of the elements.

The 14 cm. guns require new breech blocks on every gun except two. With cleaning, overhauling and slight repairs, these guns may be put in a serviceable condition.

The shield of the second gun on the port side has been perforated by an 8-inch shell.

The secondary battery is badly burned. The only portions which can probably be made serviceable are the 6-pounder barrels.

The magazines, being below the protective deck, are flooded and inaccessible; but are apparently intact.

The torpedo outfit is so badly damaged by shot and fire as to be ruined. Apparently no torpedoes were exploded.

CONDITION OF MACHINERY AND BOILERS.

The engines are covered with water to within six inches of the tops of the cylinders, and an examination of them, therefore, can not properly be made. From what can be seen, exploding shells have not struck them, and they are believed to be intact.

It can not at present be determined if any of the cylinders or heads are cracked from heat.

If the vessel is raised soon, the engines can probably be made serviceable with such work done upon them as is usually necessary to put submerged machinery in order.

The water also prevents an examination of the boilers, and a definite knowledge as to their condition can not be obtained. All gratings are in place, and there is no evidence in the trunks or other approaches to fire rooms of any boiler explosions having taken place. The boilers, however, are subjected to extreme strains, due to sudden cooling, and the tubes will probably be found to have started even if there be no greater derangement.

All the piping above the protective deck has been warped, melted and otherwise destroyed by heat.

The coal bunkers of this vessel, as well as all the others except the Cristobal Colon, were, on the 9th of July, still on fire and smouldering.

EFFECT OF GUN FIRE.

The effect of the gun fire upon the Infanta Maria Teresa was noted as follows:

Commencing at the bow on the port side:

One 6-pounder, just under the after hawse pipe on the gun deck, ranged aft; and one just below it on the berth deck in the same direction.

Two 6-pounders—one ranging aft and one forward—passed through the foremast.

One 4-inch entered the berth deck from forward just below the forward 14 cm. gun; passed across the deck and exploded.

One 6-pounder struck normal and entered the berth deck about six feet abaft the 4-inch shot just mentioned.

One 6-pounder shell struck between the forward 5.5-inch (14 cm.) and the next one to it on the gun deck and ranged forward.

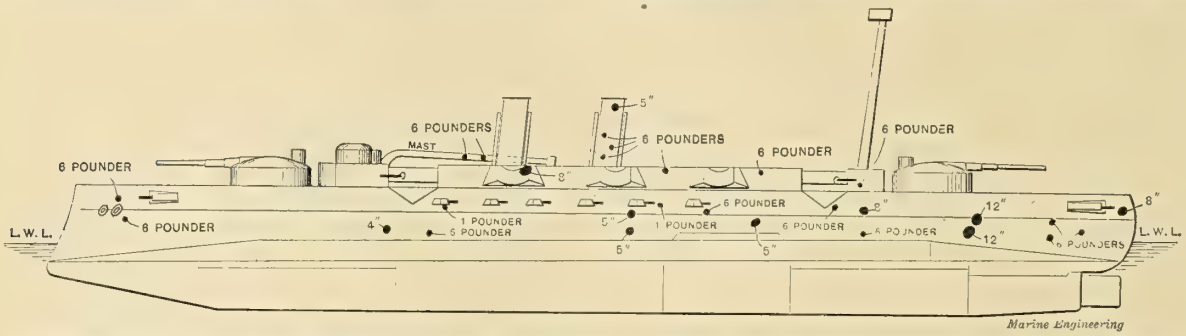
An 8-inch shell struck the shield of the second 5.5-inch (14 cm.) gun, passed through it, ranging aft and exploded. The effect of the explosion upon almost everything about the decks in that vicinity must have been terrific.

One 6-pounder passed through the ventilator just forward of the after smokestack.

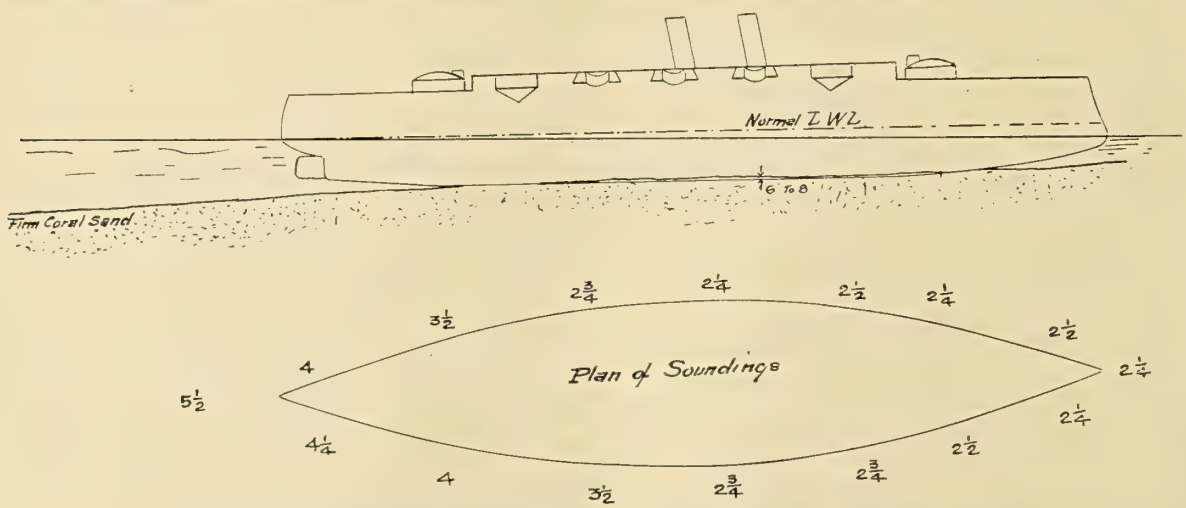
The after smokestack has a 5-inch shot hole through it, ranging from aft forward, and also three 6-pounder shot holes in the same direction.

Just abaft the after smokestack under the berth deck is a hole from 5-inch shell which ranged from forward aft. It passed through the wing passage into a coal bunker, where it exploded. The fragments ripped up the gun deck in the vicinity.

A 5-inch shell also passed into the gun deck at the same point and exploded, doing great damage in the vicinity.



INFANTA MARIA TERESA—APPROXIMATE LOCATION OF HITS AND PROBABLE SIZE OF PROJECTILES.



SKETCH SHOWING POSITION OF INFANTA MARIA TERESA ON THE BEACH.

One 6-pounder passed through the superstructure just abaft of the after smokestack.

One 1-pounder passed in just above the berth deck, normal to the surface and across the deck.

A 6-pounder passed through the side of the gun deck, between the two after 6-pounder guns, normal to the surface.

A 5-inch shell passed into the berth deck and exploded just under the same.

A 6-pounder passed into the berth deck under the after 14 cm. gun, and another shell of the same caliber passed through the after side of the superstructure on the port side, ranging forward, and normal to the surface.

An 8-inch shell struck the gun deck just under the after barbette; passed through the skin of the ship and exploded, ranging aft. The damage done by this shell was very great. All the men in that locality must have been killed or badly wounded. The beams were torn and ripped, and the longitudinal bulkheads between the two cabins was badly damaged. The fragments of this shell passed across the deck and out through the starboard side at an angle of 45 degrees. This shell also cut the fire main.

One 6-pounder entered on the berth deck, just under the 8-inch shell previously mentioned, striking normal to the surface.

Two 12-inch shells entered just under the berth deck. They entered through almost the same hole, the holes slightly overlapping. They exploded in the stern torpedo manipulating room, cutting the beams of the berth deck on the port side away from the frames, completely wrecking everything in that compartment, and made a large, ragged hole about four feet square on the starboard side. They both entered at an angle of about 45 degrees with the normal, ranging from aft forward.

One 6-pounder entered the gun deck, from aft forward, just above the holes made by the 12-inch shells.

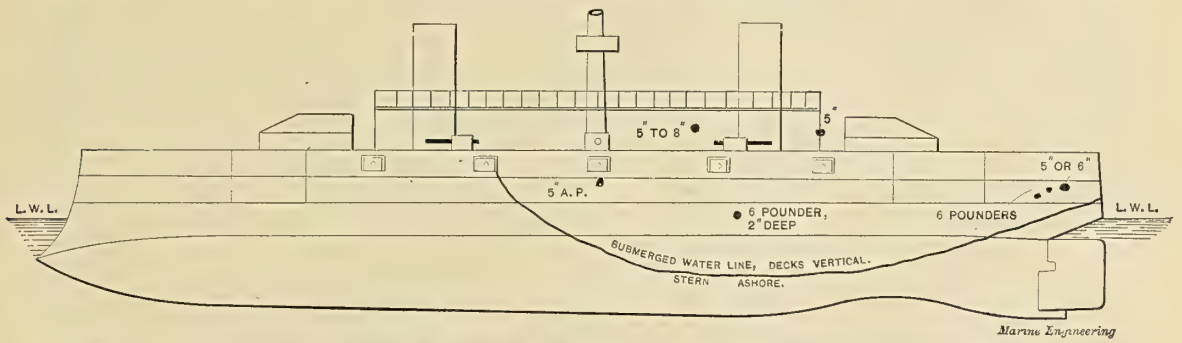
One 6-pounder entered the berth deck just to the right of the same place. The last one ranged from forward aft.

An 8-inch shell struck just abaft the sponson of the after 6-pounder, going straight through, and out the other side in the corresponding locality, without bursting.

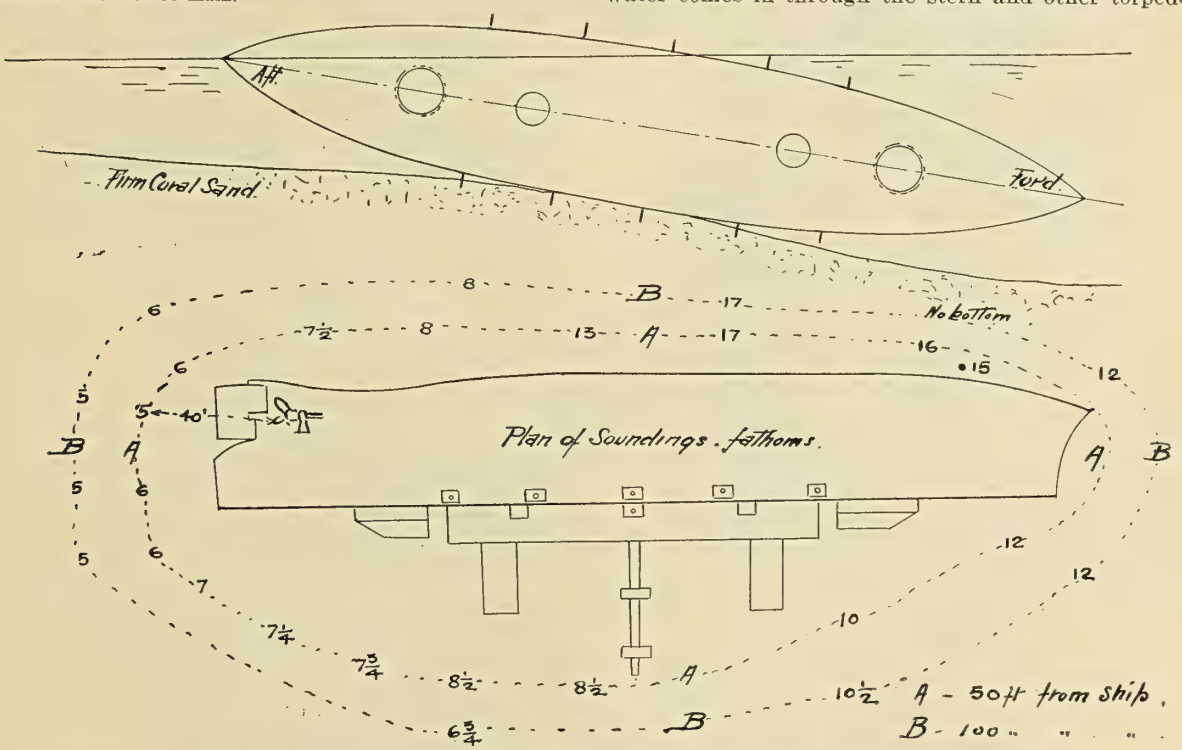
It was not practicable to locate any shot holes in the portion of the ship now under water.

CONCLUSION.

The structural solidity of this ship is not to any considerable degree injured. Barring local distortions, the hull is practically intact. The outside skin is reported by divers as intact, so far as holes are concerned. The examination extended to the bilges, fore and aft, and, in some parts near the extremities, to the bottom. The lower portion of the vessel, up to the protective deck, is filled with water. The water comes in through the stern and other torpedo tubes. The board is therefore of the opinion that it is possible and desirable to float the Infanta Maria Teresa. The vessel is lying about 100 yards from the beach, in a small cove, about five miles west of the Morro, and is grounded for the greater part of her length. The vessel lies in a very good position, with deep water astern to facilitate pulling her off. She is fairly well protected against an easterly sea. The after mast and also the funnels



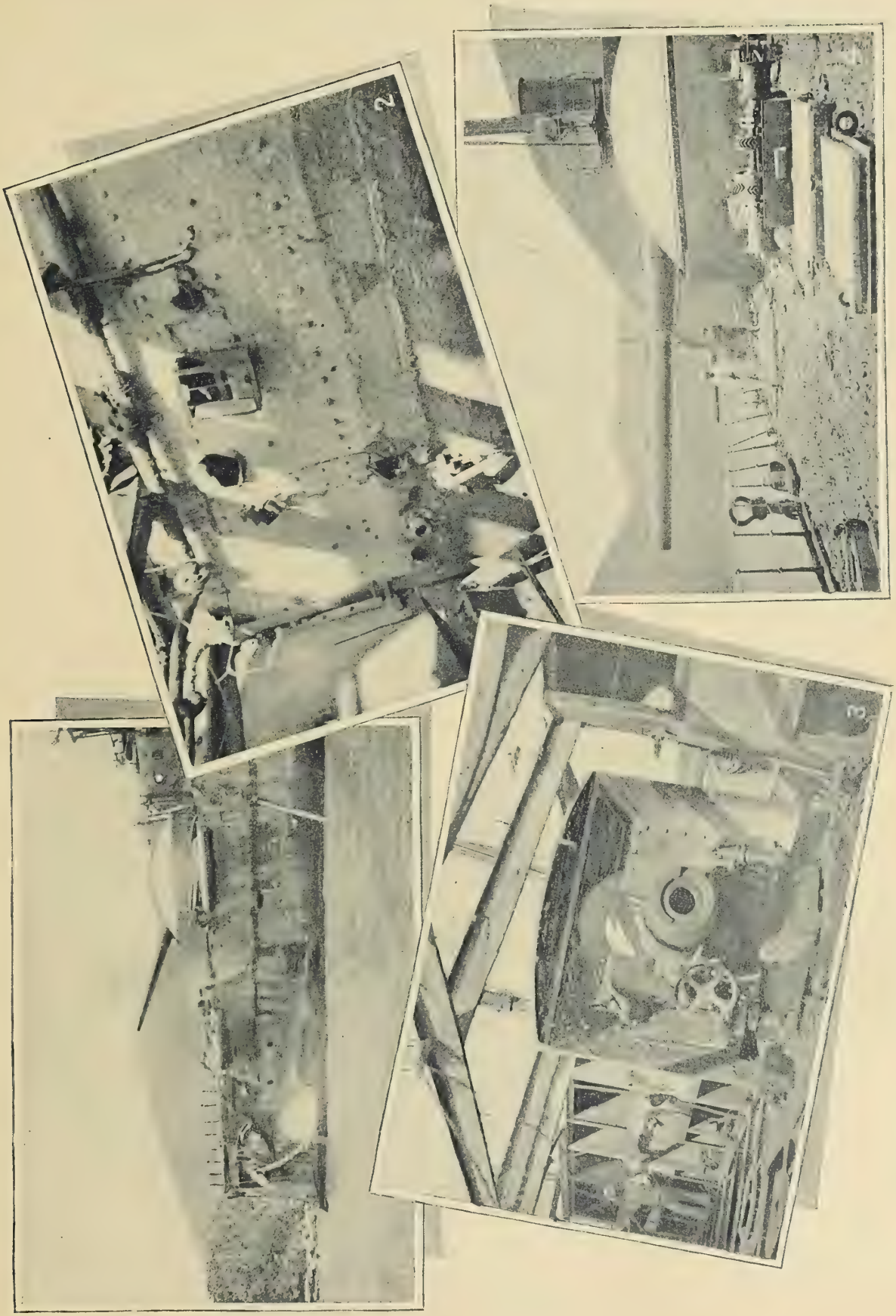
CRISTOBAL COLON—APPROXIMATE LOCATION OF HITS AND PROBABLE SIZE OF PROJECTILES.



SKETCH SHOWING POSITION OF CRISTOBAL COLON ON THE BEACH.

From Photographs taken by Captain L. W. T. Waller, U. S. Marine Corps.

U. S. OFFICIAL VIEWS OF THE WRECK OF THE CRISTOBAL COLON.—REPRODUCED BY PERMISSION.—FOR DESCRIPTIONS SEE PAGE 22.



U. S. OFFICIAL VIEWS OF THE WRECK OF THE INFANTA MARIA TERESA.—REPRODUCED BY PERMISSION.—FOR DESCRIPTIONS SEE PAGE 22.

From Photographs taken by Captain L. W. T. Walker, U. S. Marine Corps.

Cristobal Colon.

The Board found the Cristobal Colon lying on her starboard beam ends, the stern being about 150 feet from the shore, and her length lying in a direction nearly perpendicular to the line with the beach. The vessel lies several hundred yards to the westward of Rio Tourquino. The depth of water at the stern is between five and six fathoms; the bow lies in a depth of about 16 fathoms. The deck is quite vertical. The battery on the port side, with the exception of the two forward 6-inch guns, is clear of the water. The forward and second 6-inch ports are submerged. The rest of the gun ports on the port side are out of water. The bottom valves are supposed to be open. Many of the watertight door were closed by the crew of the Oregon before the vessel capsized. The bilge-keel is exposed, and also the port propeller and the propeller shaft.

CONDITION OF HULL.

The Condition of Flotation.—The vessel lies on her starboard beam ends, perpendicular to the beach, stern inshore, with about 200 feet of her length from the stern out of the water, the maximum height of deep angle above water being about 12 1-2 feet, this occurring at about 30 feet rrom the stern. stern. Apparently flooding extends throughout. Soundings indicate a firm coral sand bottom, shelving off shore. The vessel lies more or less easily, working slightly from right to left, as is to be expected from the short length of bearing surface. Examination was limited to the above-water portion. Diving was not practicable under the circumstances.

Structural Solidity—There is no deformation visible in deck or outside plating, except some dents where rocks had touched the bottom, and there is no indication of the vessel's having sustained any structural injury. The side armor gives good guarantee against local injury to the surface bearing on the bottom, and there is reason to believe that, with the integrity of the skin plating and of the decks and transverse bulkheads, the vessel can sustain herself in the present position, even in a heavy surf, without serious injury. The conditions, however, would change rapidly for the worse, with a change of direction of heading, or with movement off shore. There is no evidence of any internal explosion. Taking full account of the conditions of flotation and of the probable conditions of structural solidity, it is considered advisable that effort should be made to raise and save this vessel.

CONDITION OF ORDNANCE EQUIPMENTS, ETC.

The magazines of the Cristobal Colon and the ordnance equipment of the ship we found to be as follows: The magazines are submerged, and are supposed to be intact. The battery, apparently, is intact, with the exception of the breech locks, which are gone in most of the guns; some few remain. The guns cannot be removed in the present position of the ship.

CONDITION OF MACHINERY AND BOILERS.

It was impossible to inspect any parts of the engines and boilers, the vessel lying on her side and three-quarters submerged. As soon as raised, the machinery can probably be saved.

There is no record, or evidence, of any boilers having exploded. It is thought that the vessel was sunk after surrender, by opening sea valves and breaking their casings. After having been in the water some time, the working parts will be in bad condition, and will require the usual overhauling that any machinery would need after having been submerged.

EFFECT OF GUN FIRE.

The following hits were found on the port side of the hull and the superstructure of the Cristobal Colon:

About 12 feet from the stern, and 4 feet above the water line, one 5 or 6-inch projectile pierced the plating at an angle of about 45 degrees from the stern. This projectile came out through an air port on the starboard side, as observed before the vessel sank.

One 6-pounder struck flat below the above-mentioned spot, and above the armor belt.

One 6-pounder penetrated the plating above the armor belt, directly beneath the 5 or 6-inch above mentioned.

Between the 5-inch or 6-inch and the 6-pounder above mentioned another 6-pounder struck, without penetrating.

A 5-inch armor-piercing projectile struck the armor at the junction of No. 3 6-inch sponson, at an angle of about 45 degrees from aft. It penetrated nearly through, and the projectile rebounded.

One 6-pounder shell struck in armor below No. 4 6-inch gun sponson; impact normal; penetration two or three inches.

One 5-inch shell through the superstructure plating above No. 3 6-inch sponson.

It is reported that a projectile entered the after superstructure on the port side. Dimensions not known.

CONCLUSION.

The Board recommends that as soon as possible the Cristobal Colon should be secured by cables and anchors so that she cannot be moved from her present position. The Board recommends that the wrecking companies be directed to arrive at the earliest moment with all the facilities possible to wreck the Cristobal Colon, and is of the opinion that, if the weather continues favorable, the probabilities are good for saving the vessel.

As we go to press word has been received by the Navy Department from Captain Goodrich, commanding the cruiser Newark in Cuban waters, that the Infanta Maria Teresa has been raised and is now at Guantanamo. There she will be overhauled and put in condition to be brought to the New York or Norfolk Navy Yard.

(Report to be continued.)

Descriptions of the Official Photographs of Spanish Warships Wrecked and Sunk at Santiago, in the Naval Engagement July 3, 1898, Reproduced on Pages 20 and 21.

CRISTOBAL COLON.

1. Looking from off the bow.
2. Port screw and shaft jacket.
3. Looking forward.
4. Showing decks, guns pointing upward.

INFANTA MARIA TERESA.

1. View of wreck from bow to bridge.
2. Showing shot holes through coal bunkers. One exploded, setting fire to coal.
3. Showing 5.5 in. gun shield pierced by 8 in. shot. Crew killed. Dark object to left and below shield is a charred body.
4. Port side quarter deck, showing 11. in gun turret.

An order for a new steam yacht has been placed by P. A. B. Widener, of Philadelphia, with the Neafie & Levy Co., of that city, to replace the former vessel of the name Josephine sold to the Government as an auxiliary gunboat and renamed the Vixen. The new vessel is to be 216 ft. long, 257 ft. over all; 30 ft. 3 in. beam, and 18 ft. 6 in. deep from main deck. She will be fitted with two masts schooner rig. She will have a single screw driven by a quadruple-expansion engine, with cylinders 19 1-2 in., 28 in., 39 in., and 57 in. dia. and 36 in. stroke. Two Scotch boilers will supply steam of 200 lbs. pressure and there will be bunker capacity for 240 tons.

HIGH PRESSURE AT SEA WITH SOME CONSIDERATION OF TYPES OF BOILERS.—V.

BY W. R. CUMMINS.

In the boilers under question the gases, after leaving the combustion chamber, are well split up and distributed over the heating surface, but the distance traveled by the gases before they pass into the uptake is so small that it will be impossible to lower the temperature of the gases to an economical point. For instance, the mean distance traveled by the gases from the firebars to the uptake is only about 5 ft. in the Yarrow boiler, and somewhat more in the other varieties, against 17 ft. in the Scotch boiler. As regards weight of water over the highest heating surface, these boilers are so deficient that an automatic feed arrangement is desirable. For instance, in the three boilers taken as an example the weight of the water at 6 in. over the highest heating surface is about 2,625 lbs.; that is to say, the surface would be exposed if the feed were shut off for only ten minutes. These boilers are very accessible for cleaning, examination, and repairs, except those with curved tubes. As the whole of the surface exposed is composed of tubes, it is an easy matter to renew the whole or any part of them. All these boilers have lower drums shielded from the heat of the furnace, where grease and mud may collect without doing harm. The circulation of water in these boilers is natural, and leaves nothing to be desired. This, combined with their form, renders straining from unequal temperatures impossible, and allows steam to be raised in a very short time without the trouble of mechanical circulation. Finally, as to cost of construction, they should be one-half that of a Scotch boiler of the same heating surface and grate.

Hence boilers of this type, if built with straight tubes of fairly large diameter, would fulfil all the conditions enumerated before as necessary for a good boiler, except that of the time the gases are exposed to the heating surface, and the weight of water above the highest heating surface; the first point largely affecting the fuel economy, a very vital consideration with boilers for the mercantile marine, and the second point affecting the ease and confidence in working. The other class of water-tube boilers, comprising the Belleville, the D'Allest, the Babcock & Wilcox, and the Niclausse, have as a common feature rows of water tubes slightly inclined to the horizontal, with their ends connected in various fashions to "headers," in order to effect the circulation of water through the tubes.

As regards the thickness of the heating surface, these boilers are under the same favorable conditions as the other class of water-tube boilers. As regards size of combustion chamber, they are, generally speaking, deficient. For instance, take three Belleville boilers of the same grate surface (118 sq. ft.) as the two Scotch boilers we have been using as examples. The volume of the combustion chambers for these three boilers amounts to only 255 cu. ft., against 480 cu. ft. for the Scotch boiler, and 525 cu. ft. for the other class of water-tube boilers. Besides the deficiency in volume, they are of insufficient height, the consequence being that whenever fresh fuel is put on, some of the liberated gases reach the lower row of tubes before they have time to get heated up and combined. They pass among the tubes unconsumed until they reach the uptake. If they meet a hot current of gases from another boiler they will burn in the uptake; if not, they will pass up the funnel unconsumed. The former event is probably what happened during the first trials of H. M. S. Powerful, when the base of the funnel became red-hot. The evils of a shallow combustion chamber are aggravated by a thick fire, and to get good results with a combustion chamber of this type needs a thin fire and firing little and often.

One of the features of the Belleville boiler is the arrangement of air jets above the firebars. These jets serve two purposes: First, they tend to secure a better combustion than would otherwise be possible; and, secondly, they tend to protect the lower row of water tubes, which apparently sometimes suffer from overheating. As regards the splitting up of the gases after leaving the combustion chamber, and their distribution over the heating surface, the boilers of the type we are considering are quite equal to any of the types before considered, and as regards the distance traveled by the gases, before they pass away to the uptake, they are very superior to the other class of water-tube boiler. For instance, in the three Belleville boilers used as before for comparison, the mean distance traveled by the gases from the firebars to the uptake is about 9 ft., compared with about 5 ft. in the Yarrow boiler.

As regards the weight of water carried above the highest heating surface, this type of boiler is provided with a drum connected with the front and back headers, and if the drum is of sufficient capacity, a large weight of water can be carried over the highest heating surface. The Belleville boiler is, however, worked in a special manner and requires a feed regulator. As regards accessibility and convenience for repairs, this class of boiler is very well off, except, perhaps, in the matter of cleaning the tubes externally, especially in cases where deflectors are placed on the tubes. The tubes are all straight, of large diameter, and uniform length, thus dispensing with the necessity of carrying a great number of spare tubes and allowing for internal inspection of each tube. A majority of these boilers are provided with a mud drum at the bottom, where sediment may collect and be removed at intervals. The circulation of water in this class of boiler is satisfactory, provided the tubes are of sufficiently large diameter, and the fires are not much forced. With small tubes and forced draught there is a risk of burning the lower tubes, owing to failure

of the circulation. If there is any risk of this, and the headers are in one piece from top to bottom, they should be sufficiently flexible to allow for the unequal expansion of the top and bottom rows of tubes, as cases have happened of cracked headers due to this cause. As regards cost of construction and space occupied, this class of boiler is inferior to the other class of water-tube boiler, but much superior to the Scotch boiler.

Summing up, we may say that the Scotch boiler working at 250 lbs. pressure would burn the fuel well and utilize the heat satisfactorily, it would contain plenty of water to allow the irregularity in the feed, it would be not quite so accessible as the lower pressure boilers of the same type, and would have the same defects as to repairs of the internals. The danger from the presence of grease would certainly not be less, and the circulation would not be better. Extra care would be needed in raising and letting down steam to avoid straining from unequal temperature. Finally, the cost of construction would be more than that of the lower pressure boiler, and the space occupied only very little less.

The water-tube boilers of the Thornycroft, Yarrow, Normand, etc., type would burn the fuel well, but would not utilize the heat satisfactorily; they would have very little water to allow for irregularities in the feed, they would be very accessible for cleaning, and convenient for repairs. The circulation would be good, and there would be no danger of straining or leakage through unequal expansion. Finally, the cost of construction would be vastly less than that of the Scotch boiler and the space occupied considerably less.

The water-tube boilers of the Belleville, Babcock & Wilcox, etc., type would not burn the fuel well, but would utilize the heat satisfactorily; they would have sufficient water in them to allow for irregularity of feed, would be fairly accessible for cleaning, and convenient for repairs. If not pressed the circulation would be good, and there would be no danger of straining when raising steam or from unequal expansion. Finally, the cost of construction and the space occupied would be considerably less than that of the Scotch boiler.

There are up to the present, very few published trials of water-tube boilers on which any reliance can be placed, as the majority of them have been carried out by measuring the feed-water pumped into the boiler, but how much of this has been turned into steam is not known. The coal consumption trials of H. M. S. Sharpshooter and H. M. S. Powerful give the combined efficiency of the engines and boilers, which is very satisfactory compared with similar trials of the Scotch boiler, but how much this good result depends upon the higher boiler pressure and how much on the boiler itself is not known.

We can now pass on to discuss questions as to the best design for an engine suitable for 250 lbs. working pressure. The first question which arises is, into how many stages should the expansion be divided? When the triple expansion engine was first introduced, and effected a saving of 25 per cent in the coal consumption, its main source of economy was attributed to the use of three stages in the expansion, giving a small temperature range in each individual cylinder. This theory has of late years been to some extent discredited. The only method of getting at the truth would be to carry out a scientific experiment with engines indicating about the same power, with the same boiler pressure and number of expansions, one with two cylinders and two-stage expansion, and the other with three cylinders and three-stage expansion. No amount of theorizing will lead to any reliable conclusion, and Prof. Weighton's experiments on this subject will be awaited with interest.

As pointed out in the beginning of this paper, the economy due to raising the boiler pressure from 80 lbs. to 150 lbs. is theoretically about 23 per cent. As the maximum economy claimed by the triple expansion engine over the compound is not more than 25 per cent, there is no need to call in the three-stage expansion to account for the economy. The total temperature range for steam of 80 lbs. boiler pressure is 171 deg. F.; this, divided into equal stages, gives a range of 85.5 deg. F. for each cylinder. The total temperature range for 150 lbs. boiler pressure is 213 deg. F.; this, divided into three equal stages, gives a range of 71 deg. F. in each cylinder. That is to say, there is only a difference of 14 deg. F., under the most favorable conditions, between the temperature range of the compound and the triple expansion. Hence, in default of experiments on temperature range, we need not tie ourselves down to multiple expansion stages on account of steam economy.

The next question is that of number of cranks. The three-crank engine has now almost displaced the two-crank engine, on account of its more equable turning and balance, and four-crank engines are now coming into favor. The four cranks offer great facility for balancing the moving parts, and should, therefore, be adopted for a high number of revolutions, and where absence of vibration is of importance. They will, however, occupy more space fore and aft, thus necessitating a longer engine room, unless special means are taken to make the engine short.

The next point is the arrangement of cylinders. In the first place, tandem cylinders should only be used in cases of absolute necessity, owing to the inconvenience of overhauling the lower cylinder. Then, with three cranks, we may have two arrangements of cylinders, viz., (1) one high pressure and two low pressure; (2) one high pressure, one intermediate, and one low pressure. With four cranks three arrangements are possible, viz., (1) two high pressure and two low pressure; (2) one high pressure, one intermediate, and two low pressure; and (3) one high pressure, one first intermediate, one second intermediate, and one low pressure.

The most important qualifications for economy of design and working are:

First, the initial loads in each cylinder should be equal. Second, the cut-offs should be as late as possible, and practically equal in each cylinder, and so arranged that when working at the maximum voyage power the valve gear will be operating at its maximum efficiency. Third, the "drop" between the cylinders should be as small as possible consistent with economy of size of cylinders.

It is important to design engines with equal initial loads. It is invariably the practice to make the connecting rods, piston rods, crank shaft, anl main bearings in duplicate for each engine. Hence, if the initial loads are unequal, these parts must be designed for the maximum initial load. Speaking generally, the weight of the moving parts is proportional to the initial load and a function of the stroke, so that if a four-cylinder engine is designed with unequal loads, and the maximum is, say 10 per cent. greater than it would be with equal loads, then the weight of the moving parts of all four engines would be 10 per cent. greater than necessarv. The weight of the frame work of the engine is also affected by the initial loads; in fact, the total weight of engines of the same type should vary directly as the sum of the initial loads and some power of the stroke. It is also an advantage to have the cuts-off in each cylinder as nearly equal as possible. With the link motion there is a particular point of cut-off where the maximum efficiency is attained—that is to say, where the mean speed of steam during the admission is a maximum with a given value of travel. It will be seen that the later the cut-off the better the result, and that the efficiency falls off rapidly for cuts-off at less than 50 per cent. The cut-off in the high pressure cylinder should not be much less than 50 per cent. when linked up, as the later the cut-off the less is the proportionate loss from clearance, and an earlier cut-off than this in the other cylinders would mean a large increase of admission speed in the very cylinders where it is most difficult to get sufficient steam opening.

The best conditions as regards "drop" will be obtained if there is no drop, or a drop of a few pounds at the minimum voyage power (i. e., ship in ballast), which will give a reasonable drop for the loaded ship horse power.

Although, as pointed out above, we need not tie ourselves to multiple-expansion stages on account of any expected economy due to lessened temperature range, yet the use of more than one stage has the important effect of diminishing the sum total of the initial load, and, generally speaking, the more stages we use the less will be the total loss from drop.

Taking a cylinder 49 in. in diameter, with 4 lb. back pressure and 250 lb. initial pressure in the cylinder, the total initial load would be 463,700 lb. If, however, the expansion were divided into two stages, the total initial load would be, with cylinders 15 1-2 in. by 49 in., the combined initial load would equal 85,200 lb., a reduction of no less than 80 per cent on the single-stage load. Of course the actual reduction in weight would not be so much as this, as the weight of one engine with a certain initial load will be less than the combined weight of two engines with the same combined initial load.

For two-stage three-crank engines, with cylinders 15 1-2 in. by 34 1-2 in. by 34 1-2 in., the combined initial loads = 115,415 lb., an increase of 35 per cent over the combined loads for the two-stage two-cylinder arrangement. For the three stage three-cylinder engine, with cylinders 15 1-2 by 26 1-2 in. by 49 in., the combined initial load = 95,700 lb., rather more than with the two-stage two-cylinder arangement.

For the three-stage four-cylinder arrangement, with cylinder 15 1-2 in. by 25 1-2 in. by 34 1-2 in. by 34 1-2 in., the combined intial load = 118,900 lb., an increase of 24 per cent over the three-stage three-cylinder arrangement.

For the four-stage four-cylinder arrangement, with cylinders 15 1-2 in. by 22 in. by 32 in. by 49 in. the combined initial load = 98,500 lb., a slight increase over the three-cylinder three-stage arrangement.

The table below shows the above figures put together:

Arrangement.	Cylinders.	Combined initial load.
Single-stage.....	49	463,700
Two-stage, 2 cylinders...	$15\frac{1}{2} \times 49$	85,200
" 3 " ...	$15\frac{1}{2} \times 34\frac{1}{2} \times 34\frac{1}{2}$	115,400
Three-stage, 3 cylinders.	$15\frac{1}{2} \times 26\frac{1}{2} \times 49$	95,700
" 4 " .	$15\frac{1}{2} \times 25\frac{1}{2} \times 34\frac{1}{2} \times 34\frac{1}{2}$	118,900
Four-stage, 4 cylinders..	$15\frac{1}{2} \times 22 \times 32 \times 49$	98,500

Boiler pressure, 250 lb.
Total expansions, 18½.
Equal initial load in each cylinder.
Cut-off in first cylinder, 54 per cent.

From which it will be seen that the worst results after the single-stage arrangement is attained by the divided low-pressure cylinder arrangements.

The following table shows the cuts-off in each cylinder to give equal initial loads with the above cylinder ratios:

Two-stage, 2 cylinders, or two-stage, 4 cylinders.	Cylinders.....	$15\frac{1}{2}$	49			
	Cuts-off, per cent..	54	42			
Two-stage, 3 cylinders,	Cylinders.....	$15\frac{1}{2}$	$34\frac{1}{2}$	$34\frac{1}{2}$		
	Cuts-off, per cent..	54	27	27		
Three " 3 "	Cylinders.....	$15\frac{1}{2}$	$26\frac{1}{2}$	49		
	Cuts-off, per cent..	54	54	54		
Three " 4 "	Cylinders.....	$15\frac{1}{2}$	$25\frac{1}{2}$	$34\frac{1}{2}$	$34\frac{1}{2}$	
	Cuts-off, per cent..	54	51	33	33	
Four " 4 "	Cylinders.....	$15\frac{1}{2}$	22	32	49	
	Cuts-off, per cent..	54	55	55	57	

From which it will be seen that the greatest uniformity of cut-off is attained by the three-stage three-cylinder, and the four-stage four-cylinder, and that the cuts-off in the divided low pressure cylinders are impossibly early.

The two-stage two- or four- cylinder arrangement may be arranged to have equal initial loads, and equal cuts-off by increasing the high pressure cylinder as shown below:

Two-stage, 2 cylinders, or two-stage, 4 cylinders.	Cylinders.....	$20\frac{1}{2}$	49
	Cuts-off, per cent.....	30	30

Combined initial load = 138,700.

With the two-stage three-cylinder and the

three-stage four-cylinder it is impossible to get equal initial loads and equal cuts-off unless the terminal pressure in some of the cylinders is below the back pressure.

The latter arrangement of two-stage two or four-cylinder would be suitable if equal loads and equal cuts-off were desired, and if the total expansions were, say, 10 1-2 instead of 18 1-2, thus making the cuts-off in each cylinder 54 per cent. Of course this arrangement entails an addition of 60 per cent. to the total initial load of the unequal cut-off arrangement. It will be interesting at this point to give the actual initial loads of some three-stage four-cylinder engines. These below are for H. M. cruiser Powerful, the particulars being taken from the published indicator cards taken on her trial trip.

H. M. S. POWERFUL.

High pressure	= 213,000 lb
Intermediate pressure	= 219,300 lb
Low pressure	= 104,300 lb

It will be noticed that the initial load on each low-pressure cylinder is less than one-half the load on the high-pressure and the intermediate-pressure cylinder. If the initial loads had been equal the load on each cylinder would have been 177,000 lbs. The load on the intermediate-pressure is, however, actually 219,300 lbs., and as the rods, etc., are of the same scantlings throughout, the weight of the moving parts and the surface of the principal bearings are approximately 25 per cent greater than would have been necessary with equal initial loads. The author is not aware of the reason for this. Probably the equal initial loads would have entailed a too early cut-off in the low-pressure cylinders, and consequent insufficiency of steam opening; or perhaps the size fixed upon for the intermediate cylinder would, with equal initial loads, have brought the terminal pressure of that cylinder below the back pressure; or it may have been deemed expedient to keep the pressure in the low-pressure steam-chest as low as possible to minimize the load on the slide valves.

We can now consider the question of "drop" between the cylinders. To attempt to determine the theoretical loss due to drop would involve a very complicated calculation. In the first place, when steam expands without doing external work, it becomes superheated, or, if it contains moisture, some of the latter will be evaporated; and in the second place a given drop at a low pressure will not cause so much loss as the same drop at a higher pressure, as high pressure steam is more valuable to us than low pressure steam. Hence, to simplify matters, the drop in the following remarks has been calculated as the area or areas under a $\frac{1}{9}^{0}$ curve drawn from the terminal pressure in the cylinder to the back-pressure line of the cylinder. The proportion which this area bears to the area under a $\frac{1}{9}^{0}$ curve with the same initial pressure, back pressure, and expansions, as the cases under consideration, have been called the "percentage of loss due to drop."

The following table shows the comparative loss from drop of the different types of engine we have been considering:

Type.	Initial loads and cut off.	Cylinders.	Drop Lbs.	Loss due to drop per cent.
Two stage 2 or 4 cylinders.	Equal loads / Unequal cuts-off.	15½ × 49	81	15
Two-stage 2 or 4 cylinders.	Equal loads / Equal cuts-off.	20½ × 49	25	2
Two stage 3 cylinders.	Equal loads / Unequal cuts-off.	15½ × 34½ × 34½	75	10
Three-stage 3 cylinders.	Equal loads / Equal cuts-off.	15½ × 26½ × 49	42 / 12	4½
Three-stage 4 cylinders.	Equal loads / Unequal cuts-off.	15½ × 25½ × 34½ × 34½	21 / 1	1
Four-stage 4 cylinders.	Equal loads / Equal cuts-off.	15½ × 22 × 32 × 49	1 / 1 / 2	½

From which it will be seen that the best result is attained by the four-stage cylinder type, and the worst by the two-stage two-or four-cylinder type, with equal initial loads and unequal cuts-off.

Award of Contracts for Torpedo Craft.

Awards of the contracts for the new torpedo boats and torpedo boat destroyers have been made by the Navy Department as follows:

Bath Iron Works, Bath, Me.—Two torpedo boats, at $161,000 each, provided the company agrees to certain changes in plans.

Columbian Iron Works and Dry Dock Company, Baltimore, Md.—One torpedo boat, on Department plans, at $168,000.

Gas Engine and Power Company, Morris Heights, New York.—One destroyer, the exact price yet to be determined, as this company bid on a destroyer and a torpedo boat jointly. One torpedo boat, exact amount of bid to be determined later.

Harlan & Hollingsworth Company, Wilmington, Del.—Two destroyers on bidder's plans, at $291,000 each.

Lawley, George & Sons, South Boston.—Two torpedo boats, on Department plans, at $159, 400 each.

Maryland Steel Company, Sparrows Point, Md.—Three destroyers, on bidder's plans, at $286,000 each.

Neafie & Levy, Philadelphia, Pa.—Three destroyers on Department plans, at $283,000 each.

Nixon, Lewis, Elizabethport, N. J.—One torpedo boat on bidder's plans, at $161,000; two torpedo boats, on bidder's plans, at $165,000 each.

Trigg, William R., Richmond, Va.—Two destroyers on Department plans, at $260,000 each; three torpedo boats on Department plans, $129,750 each.

Union Iron Works, San Francisco, Cal.—Three destroyers on Department plans, at $285,000 each.

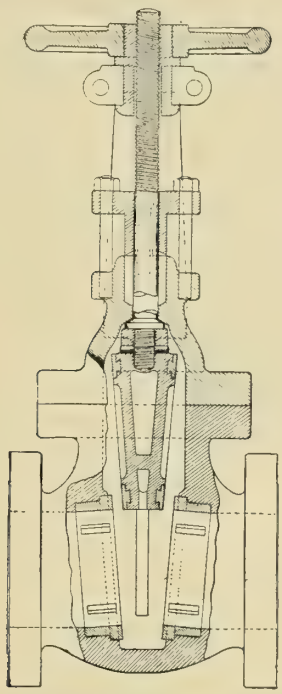
Wellington, Frank O., & Co, Fore River Engine Company, Weymouth, Mass.—Two destroyers on bidder's plans, at $281,000 each.

In the case of William R. Trigg, of Richmond, Va., the award will necessitate the establishment of a shipyard at that point within the stipulated time—three months. Arrangements are now in progress, we understand, for the purchase of a site formerly used as a foundry.

IMPROVED APPARATUS.

Improved High Pressure Gate Valve.

This drawing herewith shows an improved gate valve manufactured by the Coldwell, Wilcox Co., of Newburgh, N. Y., and which is especially adapted for extreme high pressures. It will be noticed that the body of the valve is of the oval form, all sharp corners and ribs being done away with, and the metal is so proportioned that no unequal shrinkage strains occur. The seats of the

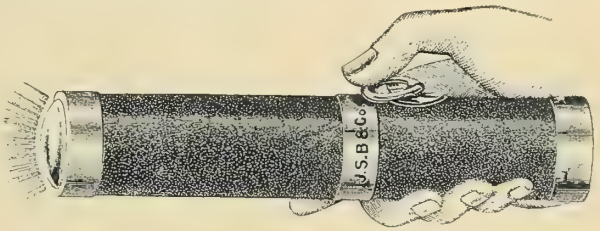


HIGH-PRESSURE GATE VALVE.

valve are of special hard bronze, made heavy, and with a long deep thread on the smaller end of the seat. The rim or larger part of the seat is turned true, and fitted to the recess turned out in the shell. The seat is screwed in and shoulders on this recess making a tight and stable joint, and being made heavy there is no danger of springing. The seats are parallel, and are screwed in to suit the angle of the wedge or gate. The gate of these valves is a heavy double shell casting, fitted with bronze bearing rings in all valves from 8 in. and upwards; under 8 in. the wedge or gate proper is entirely of bronze. The stem is made of bronze, fastened in the wedge so that the wedge is free to move and seat itself. The stem has a projection cast on above where it enters the hub of the wedge, and this turned and ground true into the seat formed in the top of the bonnet, thus enabling these valves to be packed when full open, and steam on. The stem has a thread cut on its top end to engage in a solid bronze nut, and this nut is keyed to the hand wheel, or to gearing when gears are used. The nut also extends below the portion where the thread is cut, and is fitted into a yoke cast in two pieces; the nut having a shoulder top and bottom to keep it stationary, the stem rising or lowering as the valve is opened or closed. The bronze stuffing box is made very heavy and long, and a long recess is provided for packing. About three hundred of these valves are at present in constant use, and are said by the manufacturers to be giving entire satisfaction.

Safety Pocket Electric Light.

A safety pocket light for the use of engineers and deck officers of steamships recently put on the market is shown in the accompanying illustration. It can be instantaneously lighted in any place on shipboard, on deck in a gale or in an oil tank, without fear of its going out or causing an explosion. As it is of portable size and weighs little more than one pound, it can be comfortably carried in the pocket. It is guaranteed by the makers to give approximately 6,000



POCKET ELECTRIC LIGHT.

to 8,000 "lights" before the battery requires renewal. Extra batteries are supplied and can easily be inserted in place. The light contains no mechanism which can get out of order, nor chemicals which might leak out. The manufacturers are James S. Barron & Co., 24 Hudson St., New York.

Traveling Ramps for Unloading Vessels.

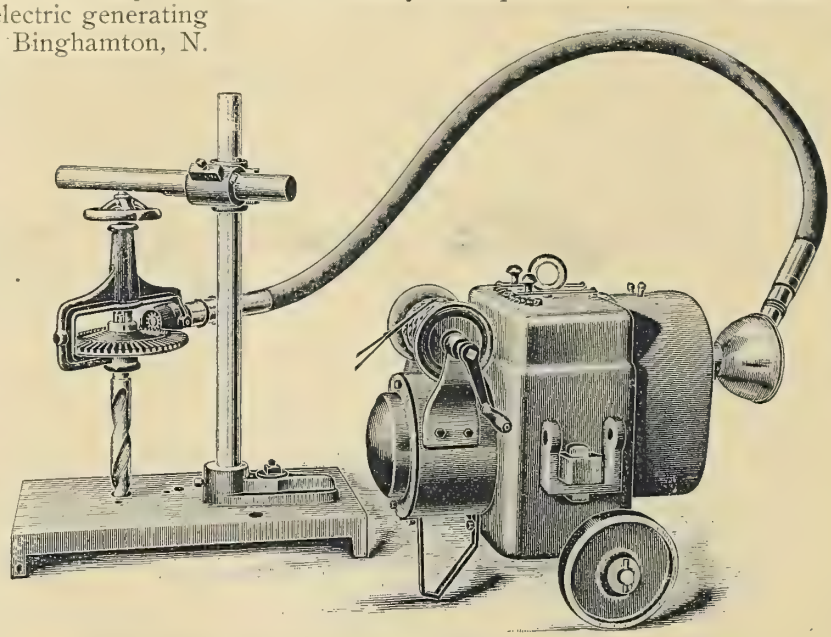
In the illustration, page 28, there is shown a device for facilitating the loading and unloading of vessels that is being introduced by the Link Belt Engineering Co. It is styled a Traveling Ramp, and in form is a development of the familiar gangplank. The apparatus is pivoted at its inboard end so that the counterweighted outboard end may be readily raised or lowered to meet the varying heights of loading ports of different vessels. It is composed of a moving section, the direction of travel of which may be reversed to carry either to or from the vessel, and a stationary gangway, upon which the freight handlers return to the warehouse or to the vessel with their empty trucks. The machine is guaranteed to increase the capacity of any steamship pier where it is used, by making it possible to load or unload vessels more rapidly than by the present methods, and it is claimed for it that it will reduce the number of men necessary and will lessen fatigue and so increase the capacity of the men who use it. The metal-covered slats composing the moving apron form recesses, between

which it will be noticed the wheels of the trucks rest, and these recesses also serve to hold in place barrels, boxes or other packages which it is unnecessary to place on trucks. A modified form of the machine dispenses with the stationary gangway, it being replaced by an additional moving section, traveling in a direction opposite to that of the other half of the machine. This arrangement makes it possible to load and unload freight simultaneously, but if only one operation is to be done at a time and it is advisable to carry the freight on trucks, these trucks need not be attended on the ramp, men stationed at the discharging end receiving and unloading them and returning them on the apron traveling toward the freight to be loaded or unloaded. Traveling ramps have been installed at the piers of the Boston Steampship Co., Boston; the Northern Steamship Co., Buffalo, and the Southern Pacific Railway Co., New Orleans. The address of the Link Belt Engineering Co. is Nicetown, Philadelphia, Pa.

TRAVELING RAMP IN OPERATION.

Flexible Shaft and Ironclad Electric Motor.

The seriousness of an accident at sea is greatly enhanced by lack of adequate tools to expeditiously make repairs. Under no other conditions is time of more vital importance. Yet of necessity, this work is largely done through the slow medium of hand tools. It would seem that under these circumstances a portable tool, simple, compact and easily transported to any distance from the souce of power, one that will bore, drill, tap or ream as rapidly as the work can be done in a well equipped machine shop, should become almost a necessity on board any seagoing vessel provided with an electric generating plant. The Stow Mfg. Co., of Binghamton, N. Y., believe that in their combination of Stow flexible shaft and ironclad electric motor will be found an appliance meeting all these requirements. The Stow flexible shaft has been so long on the market and in such general use, as to require no detailed description, but its introduction into the maritime field has only recently been made possible by the general use of electricity on shipboard. The ironclad motor is designed with special reference to use with the flexible shaft, is very simple in construction, practically dust and waterproof and unbreakable, thus peculiarly fitting it for the rough usage that a portable motor must of necessity meet at sea. The fact that by simply changing the oil cups it will run equally well in any position permits it to be used in contracted spaces, which would otherwise be inaccessible. By simply connecting the insulated wire on the reel to the power current the plant is ready for work, and can be easily transported wherever needed.



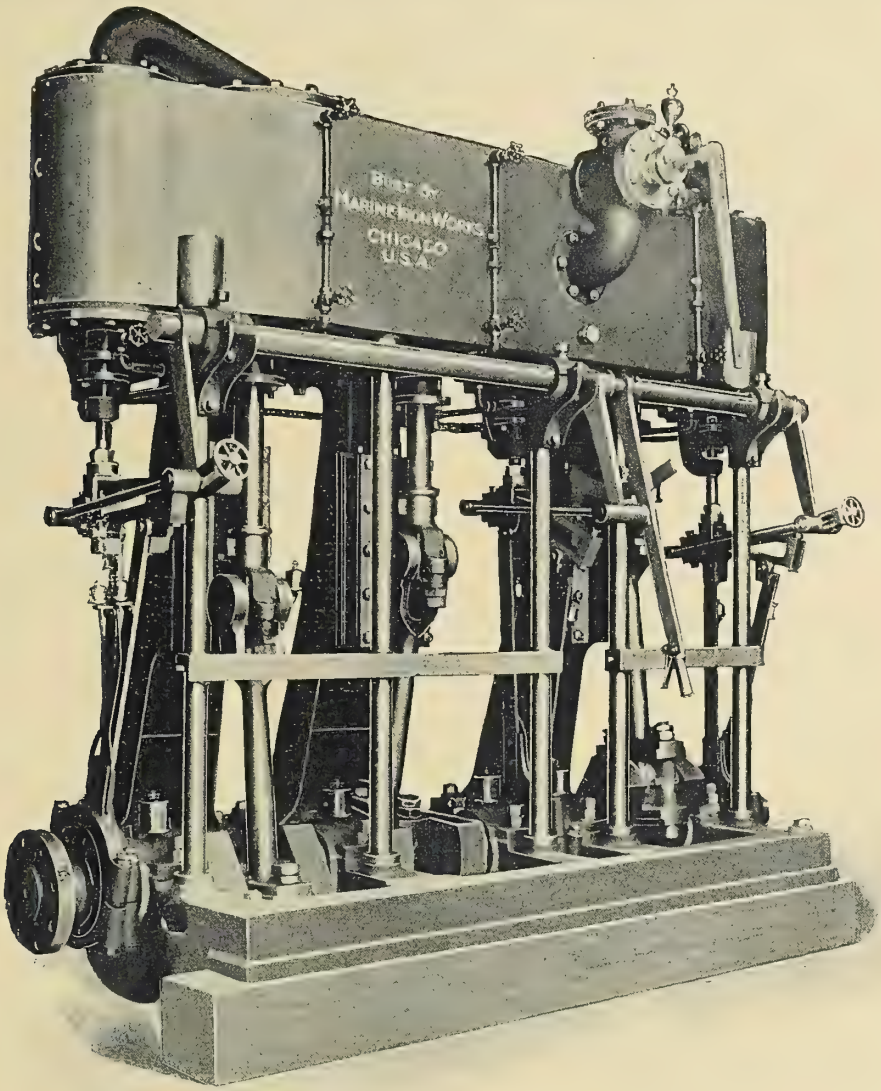
STOW PORTABLE DRILLING APPARATUS FOR SHIP USE.

This apparatus has been in use for some time in U. S. Navy Yards and in large private

shipbuilding concerns giving satisfactory results. The general European agents are, Selig Sonnenthal & Co., London, England.

Triple Cylinder Compound Marine Engine.

Our illustration shows a type of three-cylinder compound engine recently designed by the Marine Iron Works, in which compactness and light weight combined with strength and durability have been specially sought. The cylinders and finished in the journals to 5 1-2 in. dia. The crank pins are 5 1-2 in. dia. and 6 3-4 in. long. Steel is also used for the crossheads, with adjustable bronze slippers. The back columns and bed plate are made of the material usually termed "semi-steel" (cast-iron with an admixture of steel scrap), and a specially hard mixture is used for the cylinder bodies. As shown, the engine has an open front with turned steel columns, so that all working parts can be readily got at when run-



MARINE IRON WORKS—THREE-CYLINDER COMPOUND ENGINE.

are 12 in. and 18 in. dia., and 14 in. stroke. The high pressure cylinder is placed between the two low pressure, and the cranks are set at 120 deg. apart. Double-ported balanced piston valves, fitted with expansion rings, are used on all three cylinders, and are driven by Stephenson link motion. Open-hearth steel is used for the crank shaft, which is slotted out from a solid forging ning. The general dimensions are: Width of bed plate, 52 in.; length of bed plate, 90 in.; height to top of cylinders, 87 in., and weight of engine ready for steam, 9,000 lbs. The finish, without being elaborate, is of the practical kind and consistent with an up-to-date high-grade marine engine. The Marine Iron Works are located at Chicago, Ill.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.

S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representatives.

L. L. CLINE, Detroit, Mich., 47 Hodges Building.
B. M. GARDNER, Chicago, Ill., 1522 Monadnock Block.

Traveling Representatives.

E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

NOW that mutual admiration has been exhausted on the practical results of the Santiago sea fight July 3 last, it is seasonable to make some inquiry into facts of scientific interest. Popular journals of every grade and degree have iterated and reiterated statements about the landing of the heaviest shells in the enemy's vessels and the unerring marksmanship of our gunners until Baron Munchausen has appeared a model of veracity by comparison. In other columns we give some facts of interest gathered from official sources which are a surprise even to the initiated. From these it appears that while the engagement lasted our ships fired nearly 9,000 shots. A careful survey of the wrecked Spanish cruisers by a thoroughly competent board of our officers showed only 125 apparent hits. Therefore deducting the shots fired by the Gloucester at the torpedo boat destroyers Pluton and Furor (these boats could not be examined for hits) and allowing a liberal number of shots fired at these boats by our larger vessels the identified hits were less than two per cent. of the total discharges. Most singular, too, the examination did not disclose a single hit by any of our 13 in. guns in action. These results were obtained with the acknowledged good marksmanship of our gunners; what poor marksmen can do the Spanish have demonstrated.

PERIODICALLY when the loss of a liner by collision is reported the subject of bulkheads in steam vessels comes into prominence. It is one feature which, perhaps, has occasioned more thought than any other in hull construction. With some it has become a fetish to which blind obeisance is made, and they would honeycomb a vessel with partitions so that each man aboard would need a detail plan to get from one end of the ship to the other. The serious importance of the subject is well recognized however among those who design and build full powered vessels. In recent comment in the technical press there has been a good deal said about subdivision by longitudinal bulkheads with special emphasis on the supposed absolute safety which attends their use. A distinguished English contemporary cites the mishap to the City of Paris as showing the extreme usefulness of the fore and aft subdivision. Unless our memory is seriously at fault this accident was in no sense a test of the emergency efficiency of the longitudinal bulkhead. When the starboard engine went to pieces tearing away the sea connections, portions of the engine went through the longitudinal engine room bulkhead, so that the water rapidly filled both engine rooms. The engineers were driven up and the vessel rolled helplessly in the sea, with 2,600 tons of water in her engine compartments, until taken in tow and brought to Queenstown. There the sea connections on the starboard side and the bulkhead rents were plugged, the vessel pumped out and with her port engine alone she steamed to Liverpool. The longitudinal bulkhead, if permanently watertight, might prove a greater danger than safe guard in case of damage to the skin in the vicinity of the engines, for the filling up with water of one engine room would be accompanied by an inclination of the vessel to the same side. The results of a theoretical investigation into this phase of the subject are interesting. Taking a liner between 500 and 600 feet in length, the capacity of engine room compartments bounded by fore and aft and 'thwartship bulkheads was figured at lengths of 40, 60, 80, 100 and 120 feet, giving (roughly) weights of 800, 1,200, 1,600, 2,000 and 2,400 tons of water. Then presupposing a general steadiness of trim and a suitable stability curve of average or moderate amount the angles of heel produced by the inflow of water were found to be for the 40 ft.

compartment 16°, the 60 ft. 22°, the 80 ft. 25°, the 100 ft. 29° and the 120 ft. 33°. It will thus be seen that for even a moderate sized engine compartment in a twin-screw vessel, if tight, the corresponding degree of inclination would be very serious indeed, especially in rough water. The propeller of the engine in the undamaged compartment would be partially out of the water, the water level in the boilers would be very seriously disturbed and the difficulties of operation in the machinery department would be enormously increased. It is very likely too that such a permanent list of the vessel would in a liner cause a fearful panic. The longitudinal bulkhead is a good structural member if properly fitted, but it should not be without openings. We believe we are correct in saying that it is the practice now, in vessels so fitted, either to leave a permanent opening between the engine rooms or to have an opening fitted with a watertight door which is invariably kept open when the vessel is at sea. Should timely warning of an accident be given this door would be left open when all doors in the 'thwartship bulkheads would be clamped tight. Should the skin of the vessel be ruptured in either engine room both compartments would fill equally and so the only effect of the inrush of water would be to increase the displacement without seriously altering the trim or causing any heeling of the vessel. Doors in the cross bulkheads would isolate the engine compartments from the boiler rooms forward and the tunnels aft. Then the watertight door in the longitudinal bulkhead between the engine rooms would be closed, the water in the sound engine room blown out by the ejector and at the same time the water bottoms and bunkers on the same side filled with sufficient water to maintain the equilibrium of the vessel. How far this would be successful has not, we believe, been tried, and therein indeed is the chief difficulty about the whole question of bulkheads. There is little or no opportunity for experiment on a large scale. Disaster has been the only guide, and in many instances has not pointed the way toward perfection.

AN examination of the world's shipbuilding returns for 1897 compiled by Lloyd's Register of British and Foreign Shipping is pleasanter reading as history than it would have been as prophecy at the commencement of the year, so far as the United States are concerned. The figures show a tremendous falling off in the tonnage built here, a condition which is not shared to anything like the extent by any other country. This country has fallen from second place on the list, which it had held for two years, to third place, Germany moving up one step next to the premier position, occupied as a matter of course, by the United Kingdom. Returns for the last mentioned also show a decrease and this is true, too, of the Netherlands, the other maritime nations on the contrary showing increases throughout. Taking account of all vessels over 100 tons and reckoning the gross register of steamships and net register of sailing vessels the output of the United States for 1897 was 72,581 tons, or 102,280 tons less than 1896, and 24,758 tons less than 1895. Germany turned out 153,688 tons in 1897, an increase of 73,210 tons over the figures for 1896. This increase, it will be observed, was a greater tonnage than the entire output of this country during the twelve months. Returns for the United Kingdom show a total of 907,711 tons as compared with the figures for 1896, which footed up 1,121,505. This falling off can be largely accounted for by the prolonged engineers' strike, which greatly retarded the completion of vessels in British yards and probably transferred many orders to Continental builders. In France there was a large increase in new tonnage, the totals raising from 33,546 tons in 1896 to 50,940 tons in 1897. The total for all countries for 1897 was 1,286,503 tons, a falling off from the previous year, in which 1,478,375 tons were constructed, but a slight increase over the total for 1895, during which the new tonnage amounted to 1,211,615 tons. The number of vessels for all countries built during 1897 was 891, and during 1896 977. Of the former 725 were steam vessels and 166 sailing vessels. There was a falling off in the number and tonnage of sailing vessels, which, indeed, has been steadily going on for several years. In the United States the total number of steam vessels built in 1897 was 33, of 36,975 tons, considerably less than half the number during the preceding year, and the number of sailing vessels was 29, of 35,606 tons, as against 46 of 54,603 tons in 1896. Of this sail tonnage, nine were steel ships of a total of 23,079 tons, and twenty were wooden vessels of a total of 12,527 tons. The total tonnage owned by the United States was 2,448,677 tons.

EDUCATIONAL.

CALCULATIONS FOR ENGINEERS—AN AID TO CANDIDATES FOR MARINE PAPERS—I.

BY DR. WILLIAM FREDERICK DURAND.

§1. COMMON FRACTIONS.[1]

[1] One of the principal duties of the engineer is to measure things. Thus he may be called on to find the length of a section of shafting, the diameter of a piston-rod, the weight of a screw-propeller, the volume of an oil-tank, or the capacity of a coal-bunker. Measuring consists in nothing more or less than comparing the quantity to be measured with another quantity of the same kind, and so finding how many times the latter is contained in the former. Thus in measuring a length of shaft with a foot rule we really compare the length of the shaft with the length of the rule, and so find, for example, that the shaft is 14 feet in length; that is, that it is 14 times as long as the rule, or that its length contains the length of the rule 14 times. All these are simply different ways of saying the same thing. Now the foot rule or the foot in such an operation is called the *unit*.

Again, in measuring the weight, say, of a screw propeller, the operation really amounts to making a comparison between the weight of the propeller and the standard weight called the *pound*. Here likewise the pound is the *unit*.

It is easily seen that the unit must be the same kind of quantity as the thing to be measured, else no direct comparison can be made between them: thus a unit length to measure length, a unit area to measure surface, a unit volume to measure volume, a unit weight to measure weight, etc.

Now if we wish to measure the length of our section of shafting with some degree of accuracy we shall probably find that it is not an exact number of feet. We may perhaps find its length between 14 and 15 feet. We then proceed to measure the inches and find, let us say, 14 feet 5 inches, with an additional length less than one inch. With still greater accuracy we might go on and find perhaps 14 feet $5\frac{7}{16}$" as the length correct to a sixteenth. Now let us set down this length as follows: 14 feet, 5 inches, 7 sixteenths inch. It is easily seen that if the *foot* is a unit of length so is the *inch*, and so is the *sixteenth-inch*. Here then in measuring a piece of shaft we have used three kinds of units, the foot for most of the length, the inch for most of the remainder, and the sixteenth-inch for the little that finally remained. We know very well that the sixteenth-inch is obtained by simply dividing the inch up into sixteen equal parts and taking one of them, while the inch is gotten similarly by dividing the foot into twelve equal parts and taking one of them. It thus appears that these units are all related together; the sixteenth comes from the inch, and the inch from the foot.

A unit which is thus obtained by taking one of the equal parts into which a larger or principal unit may be divided is often called a *fractional unit*. Thus the inch is a fractional unit relative to the foot; while the half-inch, quarter-inch, eighth-inch, etc., are all fractional units relative to the inch. In general we can always suppose any given quantity considered as a principal unit, to be divided up into any number of equal parts, as 3, 8, 16, 100, 144, 2196, etc., and we can then take one of these parts as a fractional unit and with it proceed to measure any given amount of the same kind of quantity.

[1] The reader is supposed to be somewhat familiar with the general subject of fractions as presented in the elementary text books of arithmetic. The present section is not intended as a complete discussion of the subject, but rather as a short compendium of the more important operations, based on a point of view somewhat different from that given in the usual text books.

Now when we measure quantities with fractional units the result is known as a *fraction*. Thus the fraction five-twelfths ($\frac{5}{12}$) is the measure of a quantity in terms of the unit *one-twelfth*, just as five inches is the measure of a quantity in terms of the unit *one inch*, and in each case the measure is simply five such units. Or to put the same thing the other way around, if we measure a quantity in terms of a fractional unit such as one-twelfth ($\frac{1}{12}$), for example, and find that the measure is five such units, then we write the result $\frac{5}{12}$, and such an expression is known as a *fraction*. For the engineer it is always most natural to bear in mind this idea of a fraction, and to consider that it is simply the measure of a certain quantity in terms of a fractional unit.

When we are handling fractions simply for exercise in arithmetic we do not always stop to ask what kind of a unit it is, or what kind of a quantity we are dealing with. For an exercise in arithmetic it makes no difference, but the engineer in actual problems always knows what he is dealing with, and what kind of a unit is meant.

In the usual way of writing fractions, as $\frac{5}{12}$, $\frac{7}{16}$, $\frac{3}{10}$, $\frac{23}{144}$, etc., the number below the line is called the *denominator* and shows into how many equal parts the larger or principal unit is divided in order to furnish the smaller or fractional unit. The denominator thus shows the relation of the fractional unit to the principal unit. The number above the line is called the *numerator* and shows how many of these fractional units are used to measure the quantity in question.

Proper Fraction. In a proper fraction such as $\frac{3}{4}$ the numerator is less than the denominator, showing that the quantity measured is less than the principal unit.

Improper Fraction. In an improper fraction as $\frac{17}{12}$, the numerator is greater than the denominator, showing that the quantity measured is greater than the principal unit.

Mixed Number, or Whole Number and Fraction. Such an expression means that the quantity is measured in terms of two units. Thus $7\frac{5}{12}$ means seven principal units and five fractional units, the latter unit being one twelfth the former. This is exactly similar to the measurement of length in feet and inches, or weight in pounds and ounces. Thus if the foot is the principal unit, $7\frac{5}{12}$ means simply 7 feet and 5 inches, or if the pound is the principal unit, $8\frac{9}{16}$ means 8 pounds and 9 ounces. We may also recall the illustration used near the beginning of this section where three units were used to find the length of a piece of shafting.

---

[2] Reduction of a Mixed Number to an Improper Fraction. This means simply the reduction of the measure all to terms of the smaller or fractional unit, just as we may reduce a measure in feet and inches all to inches. Thus to reduce $7\frac{5}{12}$ to an improper fraction we see that in each of the seven principal units there are 12 fractional units, and hence 7×12 or 84 such units in the whole number. In addition, there are 5 more fractional units, and therefore $84 + 5$ or 89 in all. The reduced value is therefore $\frac{89}{12}$. In a similar way if the principal unit were the foot we should reduce 7 feet and 5 inches to inches by multiplying the 7 by 12 and adding in the 5, giving 89 inches similar to the 89 twelfths ($\frac{89}{12}$) above. We have therefore the following:

Rule—Multiply the whole number by the denominator and add in the numerator. The result is the numerator of the improper fraction, and the denominator is the same as before.

Problems—Reduce to improper fractions the following:

$$2\frac{5}{6},\ 8\frac{4}{7},\ 12\frac{7}{16},\ 8\frac{11}{12},\ 12\frac{13}{16},\ 17\frac{23}{45},\ 264\frac{123}{144}.$$

---

[3] Reduction of an Improper Fraction to a Mixed Number. To reduce an improper fraction

such as $\frac{31}{12}$ to a mixed number we must evidently find first how many principal units there are. Since 12 fractional units make 1 principal unit, it is evident that the number of principal units will be found by dividing 31 by 12. The quotient will then give the number of principal units and the remainder will give the remaining number of fractional units. Thus $31 \div 12 = 2$ principal units and 7 remainder, or 7 fractional units over; or $\frac{31}{12} = 2\frac{7}{12}$. Hence the following:

Rule—To reduce an improper fraction to a mixed number, divide the denominator into the numerator and the quotient will be the whole number, while the remainder will be the numerator of the fraction, and the denominator will be as before.

Problems—Reduce to mixed numbers the following:

$$\frac{76}{13}, \frac{198}{144}, \frac{289}{101}, \frac{56}{21}, \frac{95}{76}, \frac{143}{117}, \frac{264}{84}, \frac{764}{19}.$$

---

[4] Reduction of Fractions without Change of Value. If we change the size of a unit of measure we shall change the measure of the quantity in like proportion. Thus, for example, the number measuring the diameter of a bolt in sixteenths as a unit will be twice as great as if measured in eighths as a unit. Thus $\frac{6}{16}$ and $\frac{3}{8}$ represent the same quantity, one measure being in sixteenths and the other in eighths. It follows that we can multiply or divide both terms of a fraction (the numerator and denominator) by the same number without changing its value. Thus $\frac{2}{3}, \frac{4}{6}, \frac{6}{9}, \frac{10}{15}, \frac{14}{21}, \frac{16}{24}, \frac{20}{30}, \frac{42}{63}$, etc., all represent the same quantity measured in terms of different units, and it is seen that the $\frac{2}{3}$ may be changed into any of the other forms by multiplying both numerator and denominator by the same number, and similarly any of these latter forms may be reduced back to the $\frac{2}{3}$ by dividing both numerator and denominator by the same number.

Thus $\frac{2 \times 7}{3 \times 7} = \frac{14}{21}$ and $\frac{16 \div 8}{24 \div 8} = \frac{2}{3}$.

It may often be convenient to reduce a fraction to another of equal value but having some particular or specified denominator. To this end we divide the denominator desired by the denominator of the fraction, and multiply both terms of the fraction by the quotient. That is, we must multiply both numerator and denominator by some number which will produce the desired denominator. Thus to reduce $\frac{2}{3}$ to a fraction whose denominator is 42 we divide 42 by 3 and find 14. We then multiply both terms of $\frac{2}{3}$ by 14 and thus find $\frac{28}{42}$ as the fraction desired.

Lowest Terms. A fraction is said to be reduced to its lowest terms when there is no whole number which will divide both numerator and denominator without a remainder. Thus in the foregoing string of fractions $\frac{2}{3}$ is in its lowest terms while none of the others is. To reduce a fraction to its lowest terms we seek a factor which will divide both numerator and denominator and divide, continuing the operation until no further reduction can be made.

Example—Reduce $\frac{18}{24}$ to its lowest terms. We may first see that 2 will divide both terms without remainder. Dividing we have $\frac{9}{12}$ as a reduced value. We then see that 3 will again divide both terms, and thus find $\frac{3}{4}$ as the lowest reduction. We may also note at first that 6 will evenly divide both terms, and thus find $\frac{3}{4}$ by a single operation.

Problems—Reduce the following to their lowest terms:

$$\frac{72}{216}, \frac{350}{770}, \frac{116}{48}, \frac{864}{1728}, \frac{42}{81}, \frac{231}{1331}, \frac{56}{44}, \frac{72}{24}, \frac{19}{57}.$$

Addition, Subtraction, and Multiplication of Common Fractions.

Considering fractions as representing the measures of various quantities, we may be called upon to perform upon them the four fundamental operations of mathematics—addition, subtraction, multiplication, and division. These we will briefly consider in order.

[5] Addition of Fractions. We cannot combine directly $\frac{2}{3}$ and $\frac{3}{4}$ into a single quantity any more than we can 2 feet and 3 inches, or 6 miles and 8 feet. The reason is that the units are not the same in the two quantities which we seek to combine, and before the combination can be effected we must reduce the measures to the same unit in each. To this end we take advantage of the operations explained in [4] and reduce the fractions to a common denominator or common unit of measure. We naturally seek for this denominator as small a number as possible, and hence proceed according to the common rule for finding the L. C. M. (*least common multiple*) of the denominators. We then proceed to express the various fractions all with this L. C. M. as the common denominator by the method explained in [4]. We may then add the numerators and reduce the result as may be possible.

This is the foundation for the usual rule which may be expressed as follows:

Rule. (1) Find the L. C. M.[2] of all the denominators for a new denominator.

(2) Divide each denominator into this L. C. M. and multiply the corresponding numerator by the quotient for a new numerator.

(3) Add the new numerators thus found, and the result is the numerator of the sum desired.

(4) Write this numerator over the L. C. M. or common denominator, and reduce to the lowest terms.

Examples. Add $\frac{5}{18}$ and $\frac{1}{4}$.

The L. C. M. of 18 and 4 is 36. We then have:

$$\frac{5}{18} + \frac{1}{4} = \frac{10 + 9}{36} = \frac{19}{36}.$$

Add $\frac{3}{16}$, $\frac{2}{3}$ and $\frac{5}{6}$.

The L. C. M. of 16, 3 and 6 is 48. We then have:

$$\frac{3}{16} + \frac{2}{3} + \frac{5}{6} = \frac{9 + 32 + 40}{48} = \frac{81}{48} = \text{by reduction } \frac{27}{16}.$$

If there are but two fractions to be added and both have 1 for a numerator, a short rule for their addition is as follows: Write the sum of the denominators over their product and the fraction thus formed is the sum desired.

Thus $\frac{1}{8} + \frac{1}{6} = \frac{14}{48} = \frac{7}{24}$.

---

[6] Subtraction of Fractions. This operation requires reduction to the same unit of measure in the same way and for the same reason as in the case of addition. We have hence the usual rule, which may be expressed as follows:

(1) Find the L. C. M. of the two denominators for a new denominator.

(2) Divide each denominator into this L. C. M. and multiply the corresponding numerator by the quotient for a new numerator.

(3) Subtract the new numerators, and the result will be the numerator of the difference desired.

---

[2] For convenience in connection with these operations, we give as follows the rule for finding the least common multiple of a series of numbers—*i. e.*, the smallest number which will contain each without a remainder.

Rule—Write the numbers in a line (as (1) below), and select any number (as 4 in this case) which will divide at least two of them without remainder. Divide and set down the quotients underneath, except where the division would not be exact, in which case bring down again the number itself (as shown in line (2) below). Proceed with this line the same as with the first, and so continue until no two numbers have a common divisor. Then multiply together all the numbers remaining on the last line, together with all the divisors, and the product will give the least common multiple desired.

Example—Find the L. C. M. of 8, 36, 20, 6.

Operation:

4)	8	36	20	6....Line (1)
3)	2	9	5	6....Line (2)
2)	2	3	5	2....Line (3)
	1	3	5	1....Line (4)

L. C. M. $= 4 \times 3 \times 2 \times 3 \times 5 = 360$.—Ans.

(4) Write this numerator over the L. C. M. or common denominator, and reduce to lowest terms. Thus to subtract $\frac{1}{4}$ from $\frac{7}{18}$ we have as follows:

$$\frac{7}{18} - \frac{1}{4} = \frac{14 - 9}{36} = \frac{5}{36}.$$

If both numerators are 1 a short rule for the subtraction of the fractions is as follows: Write the difference of the denominators over their product and the fraction thus formed is the difference desired. Thus $\frac{1}{2} - \frac{1}{5} = \frac{3}{10}$.

Problems in Addition and Subtraction of Fractions. Perform the following additions:

$(\frac{1}{2} + \frac{1}{3} + \frac{2}{7})$, $(\frac{3}{8} + \frac{2}{3} + \frac{1}{12})$, $(\frac{16}{9} + \frac{2}{3})$, $(\frac{3}{5} + \frac{17}{10})$, $(\frac{243}{16} + \frac{7}{24})$.

Perform the following subtractions:

$(\frac{3}{8} - \frac{1}{12})$, $(\frac{17}{16} - \frac{7}{24})$, $(\frac{814}{144} - \frac{13}{16})$, $(\frac{430}{864} - \frac{104}{288})$, $(\frac{17}{64} - \frac{1}{4})$.

In the operation of multiplication and division we should always distinguish between the *operator* and the *subject* or *thing operated on.* Thus in 6 times 5, the number 6 is the operator and 5 is the subject. The latter is usually the measure of some quantity. The former is the sign of an operation to be performed, and this distinction, which is most important, must not be forgotten.

---

[7] Multiplication of Fractions. We shall first consider the operator as a whole number and the subject as a fraction. Thus suppose that we wish to multiply $\frac{5}{12}$ by 6. The operation is exactly the same as if we wished to multiply 5 inches by 6. The result in the latter case is 30 inches and in the former it is 30 twelfths, or as we may write it: $\frac{30}{12}$, or by reduction $\frac{5}{2}$, or $2\frac{1}{2}$. This illustrates the familiar principle that to multiply a quantity we must multiply its measure, and since in a fraction the numerator is the measure, we multiply the numerator to multiply the fraction.

Furthermore it is plain if we *multiply* the denominator of a fraction that we *decrease* the size of the fractional unit, and hence with the same numerator or same number of such units we *decrease* the value of the fraction in like proportion. Similarly if we *divide* the denominator we *increase* the size of the fractional unit, and hence with the same numerator or same number of such units we *increase* the value of the fraction in like proportion. Hence if we can divide the denominator of the fraction by the given multiplier and leave the numerator the same, it will have the same effect as multiplying the numerator and leaving the denominator the same. Thus $\frac{7}{12} \times 3 = \frac{7}{4}$.

This may also be seen by first multiplying the numerator and then reducing to lowest terms. Thus $\frac{7}{12} \times 3 = \frac{21}{12} =$ by reduction $\frac{7}{4}$. Hence we have the following rule for multiplying by a whole number:

Rule—Multiply the numerator of the fraction or divide the denominator of the fraction by the given number.

Problems—Perform the following multiplications:

$\frac{2}{3} \times 2$, $\frac{2}{3} \times 3$, $\frac{6}{11} \times 4$, $\frac{7}{12} \times 6$, $\frac{19}{14} \times 7$, $\frac{21}{36} \times 12$, $\frac{27}{432} \times 36$.

---

[8] Division of Fractions. As before, we first consider the divisor or *operator* as a whole number, and the dividend or subject as a fraction. Then we may remember that division is simply the inverse of multiplication, and that by inverting the procedure for the latter we shall effect the former. Thus to divide $\frac{18}{23}$ by 2 we divide 18 by 2 and have $\frac{9}{23}$ as the result. Or again we may multiply the denominator, thus dividing the value of the fractional unit and thus dividing the value of the fraction as explained in [7]. Thus $\div 2 =$. This being reduced to its lowest terms gives $\frac{9}{23}$ as before.

The operations on fractions involved in multiplication and division by whole numbers may be summarized as follows:

Multiplying the $\left\{\begin{matrix}\text{numerator}\\\text{denominator}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{multiplies}\\\text{divides}\end{matrix}\right\}$ its value, and dividing the $\left\{\begin{matrix}\text{numerator}\\\text{denominator}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{divides}\\\text{multiplies}\end{matrix}\right\}$ its value.

Problems—Perform the following divisions:

$\frac{6}{7} \div 4$, $\frac{2}{9} \div 3$, $\frac{6}{17} \div 2$, $\frac{21}{35} \div 7$, $\frac{16}{23} \div 4$, $\frac{15}{6} \div 3$, $\frac{231}{144} \div 11$.

---

[9] Multiplication and Division by Fractions. In these operations the *operator* is expressed as a fraction, and the latter in this case is therefore not the measure of a quantity, but the sign of something to be performed. When the fraction is used as a multiplier it is simply a short-hand way of expressing two operations (1) a multiplication by the numerator and (2) a division by the denominator. Thus if $\frac{2}{3}$ is used as a multiplier it is simply a short-hand way of expressing a multiplication by 2 and a division by 3. Thus $8 \times \frac{2}{3}$ is another way of expressing $8 \times 2 \div 3$ or $8 \div 3 \times 2$.

Similarly and since division is exactly the inverse of multiplication, when a fraction is used as a divisor it is simply a short-hand way of expressing two operations, (1) a division by the numerator and (2) a multiplication by the denominator. Thus if $\frac{2}{3}$ is used as a divisor it is simply a short-hand way of expressing a division by 2 and a multiplication by 3. Thus $8 \div \frac{2}{3}$ is another way of expressing $8 \div 2 \times 3$ or $8 \times 3 \div 2$.

When the thing operated on is also a fraction these principles work out as follows: $\frac{3}{4} \times \frac{2}{5}$ means that $\frac{3}{4}$ is to be multiplied by 2 and divided by 5. But we can multiply by multiplying the numerator, and we can divide by multiplying the denominator. Hence $\frac{3}{4} \times \frac{2}{5} = \frac{3 \times 2}{4 \times 5} = \frac{6}{20} = \frac{3}{10}$. Hence for the multiplication of one fraction by another we have the usual rule as follows:

Rule—Multiply together the two numerators for a new numerator and the two denominators for a new denominator, and the fraction thus formed is the product desired.

Similarly for division, $\frac{3}{4} \div \frac{2}{5}$ means that $\frac{3}{4}$ is to be divided by 2 and multiplied by 5. But this is the same as the pair of operations expressed by using $\frac{5}{2}$ as a multiplier. Hence $\frac{3}{4} \div \frac{2}{5} = \frac{3}{4} \times \frac{5}{2} = \frac{15}{8}$

Hence for the division of one fraction by another we have the usual rule as follows:

Rule—Invert the terms of the divisor and proceed as in multiplication.

This might naturally be expected by remembering the relation between multiplication and division, and that one is the exact inverse of the other.

For the multiplication of a series of fractions into each other these principles work out as follows: $\frac{1}{2} \times \frac{3}{5} \times \frac{2}{7} \times \frac{5}{9}$ means that $\frac{1}{2}$ is first considered as the subject and $\frac{3}{5}$ as an operator. Then the result of this is the subject and $\frac{2}{7}$ is the operator and so on. The final result will be therefore $\frac{1 \times 3 \times 2 \times 5}{2 \times 5 \times 7 \times 9} = \frac{30}{630}$. In this result we have a numerator 30 whose factors are the numerators of the individual fractions, while similarly the denominator 630 has for its factors the individual denominators. Applying here the principles of [4] we may cross out from numerator and denominator any pair of common factors. This will shorten the operation and give the result in its lowest terms. Thus shortened the above case becomes:

$$\frac{1 \times \cancel{3} \times \cancel{2} \times \cancel{5}}{\cancel{2} \times \cancel{5} \times 7 \times 9} = \frac{1}{21}$$

The propriety of striking out a common factor in both numerator and denominator may also be seen by remembering that such a pair of factors denote, one a multiplication and the other a division by the same number. These operations will offset each other and may therefore be omitted entirely.

CANCELLATION. This striking out of common factors from both terms of a fraction is known as *cancellation*, and is often of great value in simplifying an operation before proceeding with the actual multiplication and division. The following are additional illustrations.

$$\frac{14}{33} \times \frac{16}{42} \times \frac{21}{8} \times \frac{22}{18} = \frac{\cancel{14} \times \cancel{16}^{2} \times \cancel{21}^{7} \times \cancel{22}^{1}}{\cancel{33} \times \cancel{42}^{3} \times \cancel{8} \times \cancel{18}^{9}} = \frac{14}{27}$$

$$\frac{4}{81} \times \frac{15}{16} \times \frac{16}{60} \times \frac{27}{2} = \frac{\cancel{4}^{1} \times \cancel{15}^{1} \times \cancel{16}^{1} \times \cancel{27}^{3}}{\cancel{81}^{3} \times \cancel{16}^{1} \times \cancel{60}^{4} \times \cancel{2}^{1}} = \frac{1}{6}.$$

We often meet with expressions like $\frac{2 \times 3 \times 16}{9 \times 8}$ in which the number of factors in numerator and denominator is not the same. All such expressions represent a series of multiplications of whole numbers and fractions as $\frac{2}{3} \times \frac{3}{8} \times 16$, or they may be considered as denoting a series of operations of multiplication and division, and in either case it follows that their reduction may be effected by cancellation as just described. Still otherwise we may consider such expressions as consisting of a numerator and denominator each resolved into factors, and hence in ready condition for reduction by cancellation. Thus in the expression above we have:

$$\frac{2 \times \cancel{8} \times \cancel{16}^{2}}{\cancel{8} \times \cancel{8}_{3}} = \frac{4}{3}$$

Problems—Perform the following operations:

$(\frac{2}{3} \times \frac{6}{7})$, $(\frac{2}{5} \times \frac{7}{8})$, $(\frac{3}{7} \times \frac{12}{11})$, $(\frac{8}{27} \times \frac{3}{8} \times \frac{3}{3})$, $(\frac{6}{17} \times \frac{15}{8} \times \frac{1}{3})$, $(\frac{2}{3} \times \frac{4}{5} \times \frac{25}{8})$.

$(\frac{16}{3} \div \frac{4}{7})$, $(\frac{28}{9} \div \frac{7}{3})$, $(\frac{17}{144} \div \frac{13}{24})$, $(\frac{42}{65} \div \frac{7}{13})$, $(\frac{8}{23} \div \frac{7}{16})$, $(\frac{2}{5} \div \frac{17}{6})$.

[10] COMPLEX FRACTIONS. In complex fractions either or both numerator and denominator may consist of fractions or mixed numbers.

Thus for example: $\frac{2\frac{1}{2}}{\frac{3}{5}}$, $\frac{\frac{1}{3}}{\frac{2}{7}}$, $\frac{\frac{2}{5}}{3\frac{1}{5}}$.

All such expressions may most conveniently be considered as ways of indicating operations, the numerator being the subject of the operation and the denominator being the operator expressed as a divisor.

Thus

$$\frac{2\frac{1}{2}}{\frac{3}{5}} = 2\tfrac{1}{2} \div \tfrac{3}{5} = \tfrac{5}{2} \div \tfrac{3}{5} = \tfrac{5}{2} \times \tfrac{5}{3} = \tfrac{25}{6}.$$

$$\frac{\frac{1}{3}}{\frac{2}{7}} = \tfrac{1}{3} \div \tfrac{2}{7} = \tfrac{1}{3} \times \tfrac{7}{2} = \tfrac{7}{6}.$$

$$\frac{\frac{2}{5}}{3\frac{1}{5}} = \tfrac{2}{5} \div 3\tfrac{1}{5} = \tfrac{2}{5} \div \tfrac{16}{5} = \tfrac{2}{5} \times \tfrac{5}{16} = \tfrac{1}{8}.$$

The reduction of such expressions becomes therefore simply a matter of the application of the rules and methods already given.

Problems—Reduce the following:

$$\frac{3\frac{2}{3}}{8\frac{4}{5}}, \quad \frac{\frac{1}{2} + 2\frac{1}{3}}{\frac{2}{3} - \frac{6}{5} \times \frac{1}{3}}, \quad \frac{\frac{4}{5} - \frac{3}{2} \div \frac{5}{2} + \frac{3}{10}}{2\frac{2}{5} \times \frac{5}{6} - 1\frac{3}{8}}.$$

§2. DECIMAL FRACTIONS.

[1] In decimal fractions the denominator is always 10, 100, 1000, etc., or some power of 10. Instead of writing them in the usual way, however, a device is made use of to indicate the denominator without actually writing it. This is simply to write the numerator and to place a *dot* at such a point that there shall be as many figures on the right as there are ciphers in the denominator, using ciphers to the left of the significant figures if necessary to make up the needed number of places. In writing a mixed number the whole number part stands on the left of the *dot or decimal point*, which thus becomes a point of separation between the whole number and the fraction.

Thus

$\frac{7}{10}$	is written	.7
$\frac{7}{100}$	" "	.07
$\frac{7}{1000}$	" "	.007
$\frac{23}{10000}$	" "	.0023
$2\frac{7}{10}$	" "	2.7
$162\frac{43}{1000}$	" "	162.043

In each case it is seen in the decimal that there are as many places on the right of the dot as there are ciphers in the denominator, and in this way the value of the denominator or unit of measure is indicated. There are no principles involved in decimal fractions different from those already discussed in common fractions, and the only difficulties in using them arise from the peculiar manner in which they are written. We will therefore give without further discussion the rules for the handling of decimals, all of which may be seen to follow from the principles already laid down.

[2] TO REDUCE DECIMALS TO LOWER TERMS. Evidently all ciphers standing on the right of the decimal may be struck off as they disappear from both numerator and denominator. Thus .3500 = .35.

[3] TO RAISE DECIMALS TO HIGHER TERMS. Add ciphers to the right of the numerator as may be desired. Thus .35 = .350 = .3500.

[4] TO REDUCE A DECIMAL FRACTION TO A COMMON FRACTION. Write the numerator and denominator as in common fractions and reduce to lower terms if possible.

Example—Reduce .35 to a common fraction.

Operation: $.35 = \frac{35}{100} = \frac{7}{20}$.

[5] TO REDUCE A COMMON FRACTION, PROPER OR IMPROPER, TO A DECIMAL. Take the numerator for the dividend and the denominator for the divisor and proceed as in division of whole numbers, adding ciphers to the right of the dividend as may be necessary. Then point off according to the following rule:

If the numerator or dividend is less than the denominator or divisor, the first figure of the quotient must stand on the right of the decimal point as many places as the number of ciphers added to the right of the dividend in order to enable it to contain the divisor. If the dividend is greater than the divisor place the point after the figure of the quotient given by bringing down the last figure of the dividend in the operation of division.

It should be noted that this gives the general method for dividing one whole number by another and expressing the result decimally.

Examples—Reduce $\frac{16}{250}$ to a decimal.

Operation:

$$250) \begin{array}{l} 1600 \\ 1500 \end{array} \Big(.064$$

$$\begin{array}{l} 1000 \\ 1000 \end{array}$$

Two ciphers are annexed in order to obtain the first figure 6 in the quotient. Hence this figure must stand in the second place to the right of the decimal point, and a cipher is added on the left of the 6 to bring it to this position.

Reduce $\frac{1647}{25}$ to a decimal.

Operation:

$$25) \begin{array}{l} 1647 \\ 150 \end{array} \Big(65.88 \quad , \quad \begin{array}{l} 220 \\ 200 \end{array}$$

$$\begin{array}{l} 147 \\ 125 \end{array} \qquad \begin{array}{l} 200 \\ 200 \end{array}$$

The figure 5 of the quotient is given by bringing down the last figure 7 of the dividend, and hence the decimal point must come between this and the next figure of the quotient.

Problems—Reduce the following to decimals:

$\frac{2}{5}$, $\frac{12}{5}$, $\frac{122}{5}$, $\frac{18}{250}$, $\frac{17}{130}$, $\frac{18}{4}$, $\frac{143}{55}$, $\frac{1721}{1440}$, $\frac{18}{9600}$, $\frac{14}{1900}$, $\frac{23}{7}$.

[6] To Add Decimals. Set down the decimals in a column so that the points shall all stand under each other. Then add as in whole numbers and bring down the decimal point in the sum under those standing above.

Example—Add .025, .64, .231, .4685, .003.

Operation:[3]

.025
.64
.231
.4685
.003
1.3675

[7] To Subtract Decimals. Set down the subtrahend under the minuend, the two decimal points one under the other, adding ciphers to the right if necessary to fill out to the same number of places. Then subtract as in whole numbers and bring down the decimal point under those above.

Example—Subtract .263 from .83.

Operation:

.830
.263
.567

[8] To Multiply Together Two Numbers Expressed Decimally. Multiply as in whole numbers and point off for the decimal portion as many places as there are in the two factors taken together.

Examples—

.16 × 24. = 3.84
72. × .0004 = .0288
.162 × .041 = .006642
21.14 × 13. = 274.82
21.14 × .13 = 2.7482
21.14 × 1.3 = 27.482

Problems—Perform the following multiplications:

2.72 × 1.4
143.26 × 24.2
12.16 × .018
4214.3 × 22.3
.14 × .21
.06 × .0084

[9] To Find the Quotient of Two Quantities Expressed Decimally. Clear both dividend and divisor of decimals by moving the point to the right an equal number of places in each, adding ciphers as may be necessary. The number of places moved will be that necessary to clear the term of higher order. Thus modified, consider the two terms as whole numbers and proceed with the division, pointing off according to the rule given above for the reduction of a common fraction to a decimal.

Examples—

$.16 \div 2.5$ or $\frac{.16}{2.5} = \frac{16}{250} = .064$

$1.6 \div 2.5$ or $\frac{1.6}{2.5} = \frac{16}{25} = .64$

$1.6 \div .25$ or $\frac{1.6}{.25} = \frac{160}{25} = 6.4$

$16 \div .025$ or $\frac{16}{.025} = \frac{16000}{25} = 640$

$.016 \div 250$ or $\frac{.016}{250} = \frac{16}{250000} = .000064$

$1.6 \div .243$ or $\frac{1.6}{.243} = \frac{1600}{243} = 6.5761 +$

Problems—Perform the following divisions.

7.25 ÷ 16
72.54 ÷ 6.4
.00864 ÷ 14400
8.64 ÷ .0144
96 ÷ .024
1.25 ÷ .0025

[3] If desired, the numbers may be filled out all to the same number of places, by adding ciphers on the right, such operation being, in fact, the reduction of the decimals all to the same denominator or unit of measure. In the summing, however, such ciphers play no part, and therefore the filling out is unnecessary in the actual operation.

§ 3. PERCENTAGE.

[1] In percentage, fractional relations are expressed decimally, but it is understood that the denomiator shall always be 100. The fractional unit is therefore always one one-hundredth of the principal unit, and therefore occupies to it the same relation as that of the cent to the dollar. The words *per cent* are commonly represented by the symbol % so that 16% is the same as 16 per cent or .16, while 5% equals similarly .05, etc. Care must be had not to fall into confusion with the use of both the decimal point and the % mark. Thus .4% is not .4 but .4 of one per cent or .004. A number written in percentage is usualiy an operator, and not a quantity or measure by itself. Thus 16% is not a quantity by itself, but rather expresses the relation between two quantities, or represents an operation to be performed on one quantity in order to obtain another. The handling of percentages is the same as that of decimals, remembering that the term *per cent* is simply a special name for a fractional unit one one-hundredth of the principal unit, whatever the latter may be, and that it is with this fractional unit that all quantities are measured in percentage operations. Remembering the rules for decimals we readily see the following:

Examples—

16% of 80 = 80 × .16 = 12.8
3% of 2.1 = 2.1 × .03 = .063
23% of $145.24 = $145.24 × .23 = $33.4052, or $33.41.

From the above it follows that:

To reduce any number expressed in per cent to terms of decimals, we divide by 100 and express the result decimally, or shift the decimal point two places to the left; while to reduce any decimal to terms of per cent we multiply by 100 or shift the decimal point two places to the right.

Thus:

.16 = 16.%
1.60 = 160.%
.016 = 1.6%
.0016 = .16%

To Find the Percentage Ratio Between Two Numbers.

Rule—Multiply the dividend or numerator by 100 and then divide and express the result as a decimal according to the rules of § 2 [9].

Thus: $7 \div 25$ or $\frac{7}{25} = \frac{700}{25}\% = 28\%$.

Similarly:

$3 \div 50$ or $\frac{3}{50} = 6\%$

$7 \div 16$ or $\frac{7}{16} = 43.75\%$

$6.4 \div 160$ or $\frac{6.4}{160} = 4\%$

$6.4 \div 16$ or $\frac{6.4}{16} = 40\%$

$$6.4 \div 1.6 \text{ or } \frac{6.4}{1.6} = 400\%$$

$$6.4 \div .16 \text{ or } \frac{6.4}{.16} = 4000\%$$

In percentage problems it is usually required to find certain percentages of various quantities, or to find the percentage relations between various quantities. The only difficulty likely to arise is not with the operations themselves, but with a correct interpretation of the problem and a clear understanding as to the relations desired.

Examples—

(1) A broker buys a ship for $160,000 and sells her for $172,000. What per cent does he gain?

Solution: The amount of gain is $12,000. To find what per cent this is of $160,000 we proceed as above and find 12,000 ÷ 160,000 = 7.5%.

(2) A broker buys a ship for $160,000 and sells her so as to gain 6%. What was the selling price?

Solution: Six per cent of $160,000 = .06 × $160,000 = $9,600. Hence selling price = $160,000 + $9,600 = $169,600.

(3) A broker sells a ship for $171,200 and thereby gains 7% on her cost. What was the cost?

Solution: Since he gains 7% or 7 cents on every dollar of cost, there will be $1.07 in the selling price for every $1.00 in the cost price. Hence the cost price will be as many dollars as 1.07 is contained in 171,200 or 160,000.

Problems—

(4) Thirty-six pounds of gun metal contain the following:

Copper	32 pounds
Tin	1 pound
Zinc	3 pounds

Find the percentage composition.

Ans. Copper $\frac{32}{36}$ or 88.89%
Tin $\frac{1}{36}$ or 2.78%
Zinc $\frac{3}{36}$ or 8.33%

(5) A ship starts on a voyage of 2,200 miles. After going 800 miles what per cent of the voyage remains to be covered?

Ans. 63.6%.

(6) A ship starts on a voyage of 1,800 miles. After three days she has made 42% of the distance. With 12% increase of speed for the rest of the time how long will it take her to finish the voyage?

Ans. 6.3754 days.

(7) A marine engine requires 2.1 lbs. of coal per I. H. P. per hour. After certain changes are made the figure is reduced to 1.89 lbs. What is the percentage gain?

Ans. 10%.

On one ton of coal (2,240 lbs.) there was found to be 250 lbs. of ashes. What per cent of the coal was combustible?

Ans. 88.8%.

An interesting meeting of the Civil Engineers' Club, of Cleveland, was held in the Case Library on the night of September 13 last. W. R. Warner presided in the absence of the regular officers. The question of changing the name of the club to "The Cleveland Society of Civil Engineers" was discussed and put to a vote, which resulted adversely. Another proposition to rename the organization "The Cleveland Technical Society" was also negatived. At the next meeting the members will consider the adoption of the name "The Cleveland Society of Engineers." In the technical proceedings an interesting paper was read by John P. Coffin, entitled "Some Points of Interest Gathered from an Inspection of the Machinery of Vessels on the Great Lakes, Together with a Synopsis of the Rules Compiled by the Great Lakes Register for Future Construction, and the Reasons for the Same." The paper was a condensation of the results of surveys of about 1,300 vessels. In the paper mention was made of certain defects in design and proportion of machinery.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—XIII.

BY WM. BAXTER, JR.

As was shown in the last article, it is perfectly possible to convey the current of one or more generators to the circuits in which it is used by the crudest kind of wiring connections, so long as the necessary indicating instruments and operating switches are placed in the proper relation in the connecting wires. The convenience of handling the plant in the future, however, can be greatly increased by arranging the connections, and the instruments and switches in a systematic manner; and it is found by experience that the best way of accomplishing this is by constructing what is commonly called a switchboard, which may be defined as a center of distribution, as from it the currents delivered by the generators are directed into the various external circuits.

Switchboards may be very simple or very complicated, according to the service they are required to do. The simplest form of switchboard is that used in connection with a single generator. These can be made in an almost endless variety of forms. Fig. 64 shows about the simplest construction. In this diagram the outline *K* represents the board, the diagrammatic representation of the generator being directly over it. *C* represents a circuit breaker of what is called the two pole type, the name being derived from the fact that it opens the circuit on both sides of the generator armature. As will be seen, the wires *a b* which carry the generator current, pass through this circuit breaker, *a* running down the left side and thence through the ammeter *Am* and to the point *c* on the heavy broken line *1*. The wire *b* passes down the right side of *C* and connects with the heavy broken line *2* at *d*. When the circuit breaker *C* acts, the connection between *r r'* and that between *t t'* are broken, thus entirely disconnecting the generator from the lines *1* and *2*. From the points *h* and *k* wires are run to the voltmeter *V*. The rheostat for regulating the current in the shunt field coil *S* is located at the bottom of the board as shown at *R*. The two lines *1* and *2* are called bus bars and are used so as to facilitate the connection of the external circuit wires. At *s s s s* are shown four switches, one side of each being connected with bus *1* and the other with bus *2* by their upper contacts. The lower contacts *m n* are connected with the wires leading to the external circuit. With this construction it can be seen that if any of the switches *s* are closed, that is, so as to make a metallic connection between the upper and the lower contacts, that then a current will pass from the bus bars to the circuit with which the switch connects, but if the switch is open no current will flow into that circuit. As the switches are side by side, the supply of current to any part of the external system can be controlled in the most convenient manner. The voltmeter being upon the board shows at all times the pressure of the current, and the regulating rheostat being directly under it the handle of the latter can be moved so as to effect the necessary regulation in the most satisfactory manner, for the attendant can observe the effect of the change in the resistance upon the voltage by simply looking up at the voltmeter, while moving the rheostat handle. It is not always customary to keep the voltmeter constantly in circuit as instruments of this kind that can withstand such strain are expensive. When cheaper instruments are used for the purpose of testing the voltage, from time to time, a small switch is inserted in one of the wires running to the points *h k*, this switch being made with a spring that keeps it normally open.

The construction of switchboard shown in this figure is about the simplest that can be used. Gener-

ally, a main switch is provided which is located at one side of the circuit breaker *C*, or below it, and frequently circuit breakers are provided in each one of the branch circuits taken from the bus bars through the switches *s s s s*. When circuit breakers are used in these branches they are placed between the switches and the bus bars. With the construction shown in the diagram it would be necessary to provide the branch circuits with safety fuses, and these can be located at the lower end of the switchboard, at the sides of the rheostat *R*, or they may be placed back of the board, providing their location is such that they can be readily reached whenever renewals of fuses are required.

When switchboards first came into use the board *K* was placed against the side of the dynamo room; it was made of wood and the instruments and switches, all upon their own bases, were fastened to the board, and all the wire connections were upon the surface. It was soon found that the apparatus could be rendered more convenient and attractive by placing all the wires back of the board, and setting this far enough from the wall to afford free access behind it. It was next found that wooden boards were liable to be set on fire by the flashing of the circuit breakers and large switches, therefore marble and slate were substituted in the construction of *K*.

When more than one generator is used, the simplicity of switchboard construction shown in Fig. 64, apparently, has to be departed from, but in reality there is no more complication in one case than in the other; there is simply a duplication of the various parts. This can be made quite evident by means of Figs. 65 and 66, which are diagrammatic representations, in a simplified form, of switchboards for three generators, the first being arranged to feed into one system of external distribution, and the other to feed into three independent systems. In both figures, the volt and ammeters as well as the switches, circuit breakers and field regulating rheostats are omitted so as to leave only the skeleton outlines of the main circuit wires. In Fig. 65, the lines *1*, *2* and *3* are the bus bars, *1* being known as the equalizing bus, and taking the place of wire *B* of Fig. 63. Buses *2* and *3* are the terminals to which the external circuits are attached. As there are three generators, it will be evident, at once, that these should be so arranged that any one may be disconnected from the circuit whenever desired, hence, there must be a switch by means of which the connection between each generator and the bus bars may be broken. It is also evident that for one reason or another, the

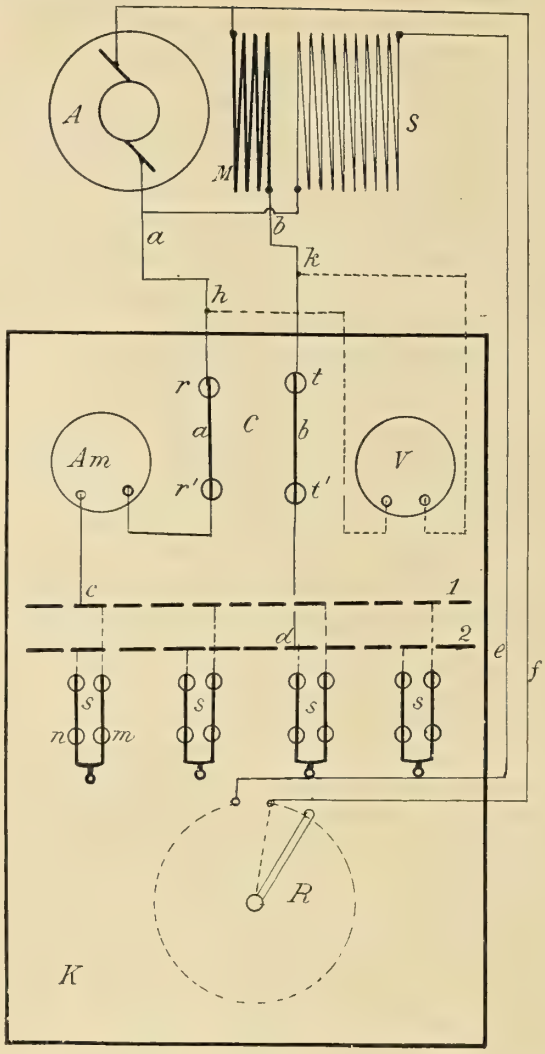
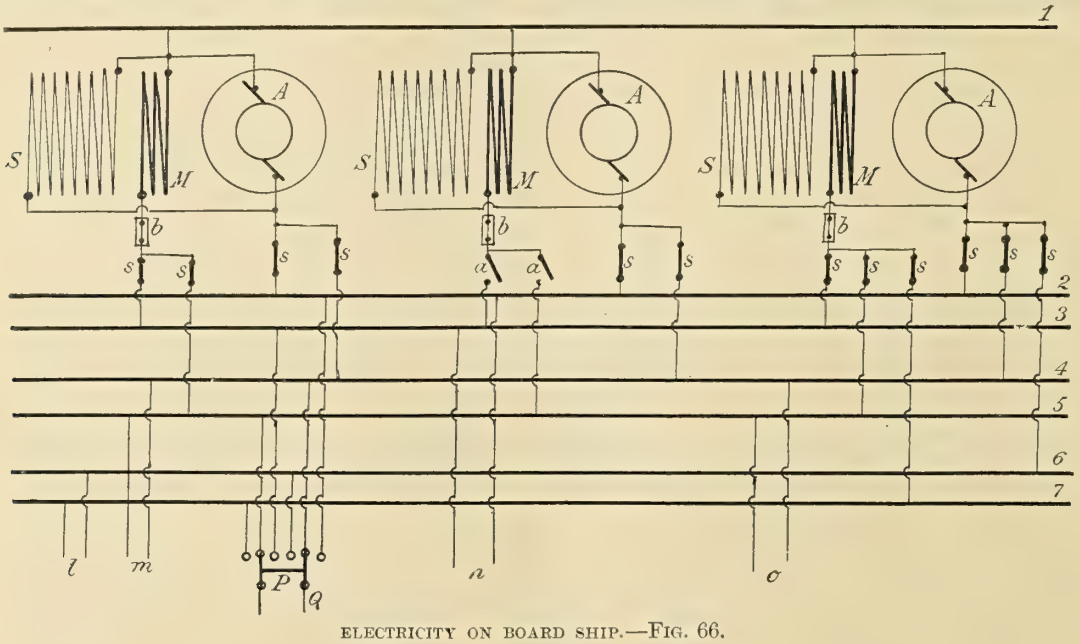


FIG. 64.



ELECTRICITY ON BOARD SHIP.—FIG. 66.

current passing through any one of the generators may become dangerously strong, hence, each machine should be provided with an independent circuit breaker. As to the external circuits *a*, *b*, *c*, *d*, it is also clear that it may be desirable to disconnect these sometimes, and also that it is possible for the current flowing in any one to become greater than the wire can carry with safety, therefore, each one of these circuits should be provided with an independent switch and an independent circuit breaker. In the way of instruments, it is desirable to have an ammeter and a voltmeter for each generator, and it is also desirable to have an ammeter and voltmeter to indicate the total current passing into the external circuit as well as the actual voltage acting upon the line.

In a case such as shown in Fig. 66, when there are a number of independent external systems of distribution as well as a number of generators, it is not only necessary to arrange the machines so that any one can be disconnected, but it is also desirable, if not actually necessary, that means be provided whereby any machine may be connected with any of the external circuits. In the figures the two machines on the left are shown with connections leading to two sets of bus bars, and the generator to the right is shown connected with all the buses. By means of the switch *S S S*, the generators can be arranged to feed into all the buses with which they connect, or with any one of them. By means of switches constructed as shown at *P*, any of the external circuits can be transferred from one system to any other. From this it will be seen that when there are a number of generators, and these feed into two or more independent external systems, it is desirable, and in most cases necessary, to provide switches whereby any macine may be connected with any external system, or may be entirely disconnected from all; and also to provide switches by means of which any part of the external circuit may be transferred from one system to any other or be disconnected from all. It will further be realized, that there is no special difficulty in the way of accomplishing all these results, and this fact will be made still clearer in the succeeding articles.

An important transfer of manufacturing interests in the electrical field has recently taken place in the purchase by the Westinghouse Electric & Manufacturing Co. of the stocks and bonds of the Walker Company. The principal owners of the latter company will, it is understood, get an interest in the consolidated company and seats in the board of directors.

ENGINEERS' DICTIONARY—X.

Cock.—A device for controlling or directing the flow of a liquid, gas or vapor. The simple plug cock con-

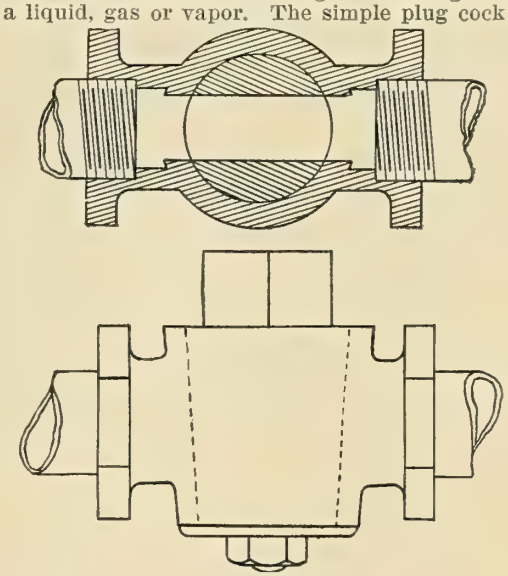


FIG. 29.

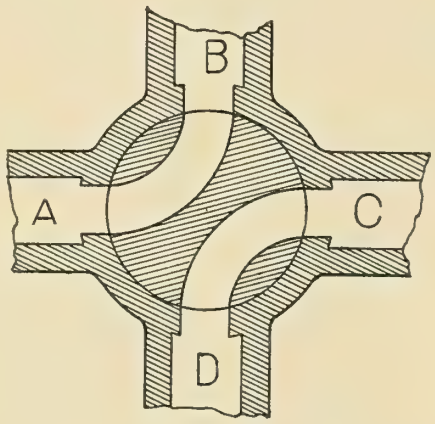
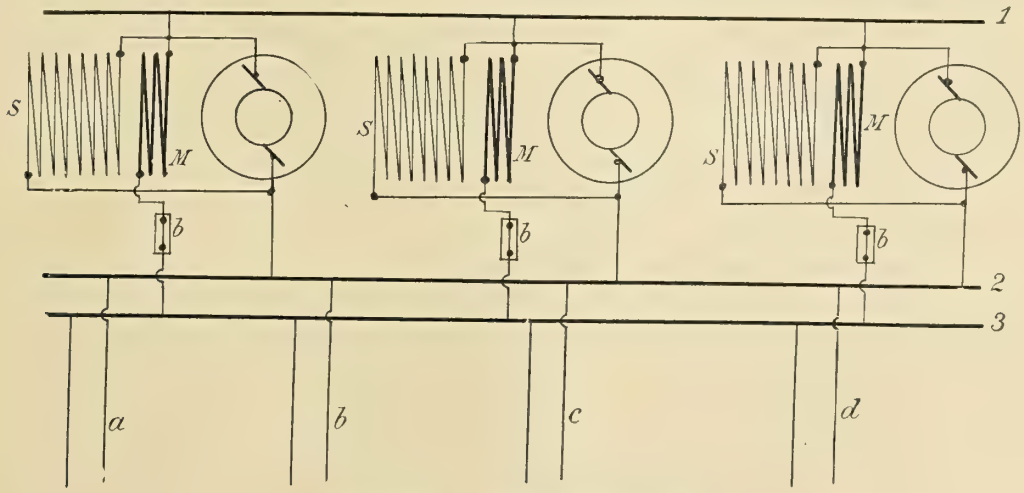


FIG. 30.

sists of a slightly tapering plug fitting a casing or chamber and having a hole or passage through from



ELECTRICITY ON BOARD SHIP.—FIG. 65.

one side to the other, as shown in Fig. 29. The passage is open or closed, according to the position of the plug. In a cock of the form shown in Fig. 30 the passage *A* is connected to *B*, and *C* to *D*, while by a quarter turn *A* becomes connected to *D* and *C* to *B*.

Column.—The part of a vertical marine engine which directly supports the cylinders and connects them with the bed-plate. The guide surfaces for the cross-heads are also either formed on the columns or supported by them. Columns are made of cast-iron, cast-steel and forged-steel. When of cast metal they

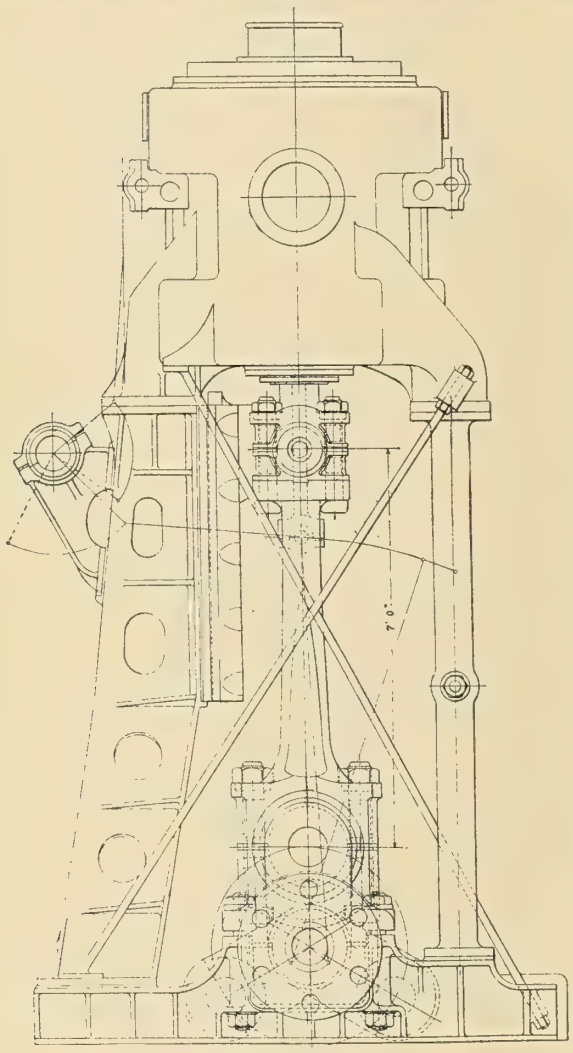


Fig. 31.

are usually in the form of an inverted Y and of hollow or box girder section. Such are therefore known as *inverted Y columns*. When forged they are cylindrical or slightly tapering, and sometimes hollow. Cast inverted Y columns on the back and cylindrical forged columns in front, as in Fig. 31, are very commonly used in marine practice at the present time, especially with single *slippers*.

Combustible.—That part of coal or other fuel which can be burned; or the fuel less the ash. For coal, the amount of combustible is usually from 85 to 95 per cent.

Combustion Chamber.—A chamber into which the products of combustion in a boiler pass before entering the tubes. Its chief purpose is to provide an opportunity for the completion of the combustion, especially of hydrocarbon gases given off from bituminous coal. See also under *boiler*.

Compression or *Cushion.*—In the cylinder of a steam engine the exhaust is usually closed before the piston has reached the end of the stroke. This results in the compression of the steam thus shut in, from the volume at the instant of closure to the volume of the clearance. This operation and this part of the cycle are known as the *compression* or *cushion*, and the operation is frequently termed *cushioning*.

Compound Engine.—An engine in which the total expansion is divided into two stages, the steam entering first the high-pressure or smaller cylinder, thence exhausting into the low-pressure or larger cylinder, and thence exhausting to the air or to the condenser.

Concentration or *Saturation.*—Terms used to denote the relative amount of solid matter in the water in marine boilers. See *Brine*. Ordinary sea water contains about one part in thirty-two of solid matter in solution, and this being taken as a standard its concentration is called 1. A concetration of 2 or 3 means, therefore, two or three times as high a proportion of solid matter as in common sea water. With surface condensers, but without fresh auxiliary feed from evaporators or tanks, the concentration on long runs will rise to 3 or 4, and is usually kept from higher values by occasionally blowing off a portion of the water in the boiler and replacing it with sea-water as an auxiliary feed. With fresh feed the concentration can be kept down to a value depending simply on the tightness of the condenser, and the absence of salt-water leaks into the feed. The concentration is tested by means of a special form of *hydrometer* or *salinometer*, as it is frequently called.

Condenser.—The apparatus by means of which the exhaust steam is reduced to the state of water. Condensers are of two types—*jet* and *surface*.

The former consists of a chamber of rectangular or cylindrical form in which the steam and water are intimately mingled by jet orifices. The condensed steam and water fall to the bottom of the chamber, and are thence removed by the air pump, a portion being taken by the feed pump for boiler feed.

The usual type of surface condenser, see Fig. 32, consists of a chamber commonly of cylindrical form if separate, or rectangular if forming part of the en-

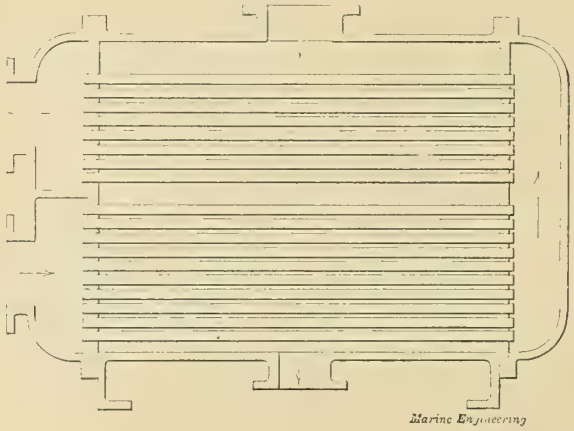


Fig. 32.

gine columns. This chamber contains, as shown, a large number of small brass tubes running between the inner walls of the heads, which are double. This form of head provides a connection between the ends of the various tubes. The condensing water is driven by the circulating pump through the tubes, while the steam is exhausted from the engine into the body of the chamber, and thus around the outside of the tubes. The steam and the condensing water are thus kept separate, and the steam is condensed simply by

the surface action of the tubes. The steam thus condensed to water falls to the bottom of the condenser, whence with some air and vapor it is removed by the air pump and delivered to the hot well, whence it is taken by the feed pump and sent back to the boilers. The amount of condensing surface is usually proportioned to the power developed by the engine, from 1 to 1.5 sq. ft. per I. H. P. covering the range of usual practice with modern triple-expansion engines.

Condenser-Tube.—A tube used in a surface condenser, usually of brass and 5-8 in. or 3-4 in. outside diameter.

Condenser-Tube Packing or Ferrule.—A form of packing used to make a water-tight joint between the condenser tubes and the inner heads or tube plates; and at the same time to avoid rigid constraint of the tube. The most common type of condenser tube packing is shown in Fig. 33. The tube plate is counterbored as shown and threaded for a ferrule with a

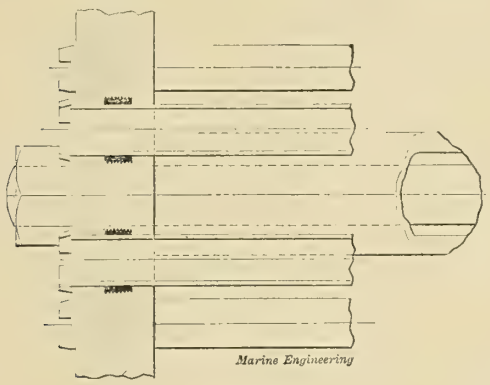


FIG. 33.

tapering outer end, and hence with a hole smaller than the outside of the tube, but not smaller than the inside. Between the end of the ferrule and the bottom of the counterbore is usually a ring of rubber or corset lacing as an elastic packing. Screwing down on the ferrule compresses the packing, and thus makes the joint. The tube is free to expand and contract slightly, but is prevented by the outer ends of the ferrules from crawling to such an extent as to free either end.

Cooling Surface.—Another name for *condensing surface*. See *Condenser*.

Corrosion.—The destruction of metals by chemical action. The usual forms of corrosion are two in number—*oxidation* or *rusting* and *acid* corrosion. The former is due to the union of oxygen with the metal. For the continuous rusting of iron or steel, three conditions are necessary: the continuous presence with the metal of *oxygen*, *moisture* and *carbonic acid*. A removal of any one of these will prevent continuous rusting. Painting insures the absence, more or less perfectly, of all three. Quicklime insures the absence of moisture as well as carbonic acid. Immersion in water made alkaline by lime or soda insures the absence of carbonic acid and oxygen except in slight amount. Acid corrosion is due to the union of the metal with an acid, which on board ship is very commonly *hydrochloric* or *muriatic* acid, according to the common name. Corrosion of this character may be counteracted by a protective coating not subject to the attack of the acid, or by insuring the presence of an alkali to neutralize the acid. Corrosion also depends much upon *electro-chemical* action, or to state the relation more generally, the electric relations of the different metals to each other and to a liquid with which they are in contact, and the consequent electrical actions, may increase very notably the amount of chemical activity.

QUERIES AND ANSWERS.

Q.—Are marine engines sufficiently governed to prevent racing at all times when the propeller is emersed. If not, why not?

Describe the most effective type of marine engine governor. W. G. H.

A.—The subject of governing a marine engine to prevent racing in a seaway is one on which considerable labor and experiment has been expended for the last 35 years, as the great variety of patents on governors will attest.

When steam was first introduced in vessels the engines were governed by hand, and as the main stop valves in those days were of simple construction they took considerable time to open or close, so a butterfly valve was placed in the main steam pipe which, although it would not close steam-tight, would effectually check the flow of steam to the engine, and could be operated very quickly. Later on automatic gear was installed in connection with the butterfly valve to take the place of the engineer at the lever. In latter years the butterfly valve has not been used to any great extent, as main stop valves are now balanced so that they can be operated quickly, and as with high pressure steam a small amount of priming will sometimes carry the butterfly valve along with it into the steam chest.

In modern triple and quadruple engines it is impossible to suddenly check by means of the throttle because the quantity of steam remaining in the intermediate and low pressure receivers, with the help of the vacuum in the condenser, will still cause the engine to run abnormally fast if it is relieved of its load. This fact was noticeable even in compound engines, and was remedied by connecting the automatic gear with a valve in a pipe running between the top and bottom of the low pressure cylinder, so that when the throttle valve closed the pressure was at the same time equalized in both ends of this cylinder by the opening of this equalizing valve.

Nowadays the automatic controlling gear is usually connected to the reversing gear, linking up all the valves at the same time, sometimes even throwing the links amidships, or linking up part way as necessary, and then linking full out again when the propeller is again submerged. This linking up has one disadvantage from the fact that it causes an excessive fluctuation of pressure in the valve chests and endangers the joints in the receiver pipes, so the latter must be made strong enough to withstand it.

It has often been asserted that the greatest strain in shafting occurs when the engine is running full power ahead with the propeller entirely submerged; an opinion which seems to be verified by the fact that by far the greatest number of breakages of shafts have happened when running under this condition. It is also well known that it is impossible to develop high power when the ship is laboring, as the firemen cannot stand up to their work as well as when in smooth water. It is also evident that a propeller which is stopped suddenly is a drag or detriment to the speed of the ship, and although the vibrations imparted to a vessel, especially a twin-screw vessel, by the blows of the blades of partially submerged propellers are very annoying, it is not good policy to stop them entirely, but to simply endeavor to reduce the revolutions in proportion to the depth of submersion.

It is difficult to design a gear which will properly control the engine under all conditions of draught, wind and weather; but nearly all the gears are so constructed that they can be adjusted to cope with varying conditions, as the latter do not change suddenly.

The large high-powered transatlantic liners nowadays are of deep draught and fitted with fast-running engines and propellers with large driving surfaces. These are of comparatively small diameter, and are submerged to a considerable depth, and as the great length of these ships prevents excessive pitching the question of the racing of the propellers is not so important as in liners of former years.

It would be out of place in this article to name any particular make of governor, but a short description of a few types and their action will probably be of aid to you.

Marine governors may be divided into two classes: those actuated by the pressure of the water under the stern of the

ship, and those actuated by any sudden increase in the normal speed of the engine. In the first variety a cock is attached to the inside bottom of the ship at the stern, connecting with an air vessel and, by means of a pipe, to a chest with a spring-loaded diaphragm in the engine room. The cock is of the three-way variety, so that the air vessel and pipe may be drained of water at any time that it may accumulate. When the cock connects the system with the sea the water pressure, due to the depth, compresses the air in the system, compressing the spring on the leather diaphragm. If, however, the stern should rise, the pressure would diminish and the spring will depress the diaphragm. In some cases the diaphragm is made large in diameter and is connected directly to the throttle lever; in other cases it is made quite small and operates the small piston valve of a steam cylinder, which is turn works the throttle valve and also the equalizing valve on the low-pressure cylinder. The tension of the spring on the diaphragm can be adjusted to suit the different conditions of weather, etc.

Of the second class, those actuated by an increase in revolutions, there are a greater number to chose from. Following is the description of a few types: A driving pulley, located at some convenient place on the shaft, revolves, by means of a belt, a small spring-ball governor similar to those used on land engines, the spindle of which controls the valve of the power gear connected to the throttle or reversing lever. In another type the belt drives a shaft with a helical spring attached at the end, the axis of both being identical. The free end of the spring has a fan paddle wheel attached, so that when the shaft is driven the fan is also revolved by means of the intervening spring. Any sudden increase in speed drives the fan faster, putting a greater resistance on the spring, tending to uncoil it, and the axial lengthening of the spring due to this operates the power gear to the throttle. In another type the fan works on a coarse-threaded screw and is held in place by a spring. The screw is driven by the belt, and any increase in speed will cause the fan to overcome the resistance of the spring and run back on the screw and operate the throttle gear. In another style of gear the increase of speed will cause weights controlled by springs to move outwards from the belt-driven shaft, after the manner of the ball governor, and engage an outer ring similar to a friction clutch, revolving the same and thus operating the throttle gear. The diaphragm has also been used in connection with the latter class of governors. The main engine shaft drives a small pump or turbine, which forces a liquid into a chest fitted with a spring-loaded diaphragm. The discharge pipe from the chest runs back to the suction of the pump or turbine, and can be throttled by means of a cock so that a certain pressure can be maintained in the chest at normal speed of the engine. When the engine suddenly increases in speed the pressure in the chest rises correspondingly, as the outlet has not the area to pass off the increased quantity of liquid, and consequently the diaphragm is compressed and controls the engine by means of intermediate gear.

At first sight it would seem that a pendulum would be a good device to operate a throttle gear. A following sea, however, will cause a ship to pitch when it lifts the stern and the propeller will still be under water, so the pendulum gear has been abandoned.

There is still another type of gear in use operated by increase of speed, but driven without the intervention of a belt. It consists of a small rod, with stoppers at each end and a weight sliding on it. The rod is attached to any oscillating part of the engine, preferably near the reversing or throttle gear and usually placed on the pump levers, the axis of the rod coinciding with the direction of motion. If the weight were not held fast it would bob up and down along the rod, due to the momentum imparted to it by the oscillations. The weight is pressed against one stopper by means of a spring, and the tension is so adjusted that the weight cannot move on the rod until the engine exceeds its normal speed, and then the momentum overcomes the tension, and the weight, bobbing on the rod, moves a small lever attached, operating the throttle or reversing gear. This type of governor is sometimes applied only as a safety gear to quickly throw the links amidships and let them remain there in case of breakage of a shaft, as an accident of this kind releases the engine from all load, so that it will race so fast as to fly to pieces unless it can be instantly controlled.

It is evident that in nearly all of these types it takes an appreciable amount of time to impart the movement of a small, delicate piece of mechanism through the different power multiplications to the throttle reversing gear, and this has been the main difficulty with many different gears, as they were so slow that the engine would race at first and only be checked when the propeller was again going under water. If, on the other hand, the gears could be made to work instantaneous, the engines would maintain uniform speed, which is also undesirable, as explained heretofore.

The best working governors are adjusted to check the motive power suddenly when the engine slightly exceeds the normal speed, as a gradual shutting off would not sufficiently overcome the momentum of the parts of the engine; they release quickly so as to make an allowance for the time consumed by the engine to acquire speed again. In other words, the governor over-run itself both ways.

A governor must be simple in construction, so that it will not be liable to get out of order. It must occupy little space, and that space to be in an out-of-the-way place so as not to interfere with the work around the engine, and also so arranged that it can quickly be thrown in and out of action.

Q.—Why is drilling better than punching for making holes in boiler plate? NAVY YARD.

A.—Drilling is better than punching because the metal of the plate is not so severely tried by the former operation as by the latter. In punching, a thin skin of metal about the hole is so severely strained that its strength, and especially its ductility and toughness, are reduced far below what they are in the remainder of the plate. This is not the case with the drilled holes, or at least not to anything like the same extent. Drilled holes may also be located more accurately than punched holes, and thus with the former the parts of a riveted joint may be more perfectly fitted than with the latter. The operation of drilling leaves, however, a sharp edge which should be removed by a reamer in order to avoid any tendency to cut the rivet. The punched hole is naturally somewhat tapering, and is therefore more directly suited to countersunk or flush-point riveting than the drilled hole. In the latter case, for this class of work, the hole must be reamed or drilled out tapering by a special operation. In spite of the greater cost of drilled holes, however, they are now generally accepted as the best for high-class work, and in many specifications no holes are allowed to be punched.

Q.—What are the relative sizes of compound engine cylinders? L. N.

A.—In the early days of compound engines, when the pressures employed were in the neghborhood of 100 lbs., the ratio between the areas of the two cylinders was usually not far from 2, which gave a ratio between the diameters of about 1.4 or 1.5. Not uncommonly three cylinder compounds were made with three cylinders of equal size, one for the H. P., and two acting together for the L. P. With the gradual rise in steam pressures the ratio between the cylinder areas has also increased until values of from 2.5 to 4 are met with. These correspond to diameter ratios of from 1.6 to 2.0. Extreme cases are also occasionally met with where the area ratio rises to 4.5 or 5, corresponding to a diameter ratio of from 2.1 to 2.3. Such engines have been likened, in proportion, to a triple-expansion engine with the I. P. cylinder removed.

Q.—How much air is required to burn one pound of coal? C. H. B.

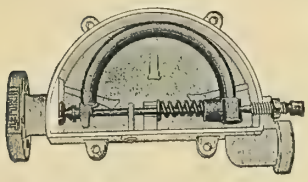
A.—The *burning* of coal means chemically its union with oxygen. It requires just 2 2-3 lbs. of oxygen to burn one pound of carbon, and practically the same amount for one pound of coal. The air, however, contains only about 23 per cent of oxygen to 77 per cent of nitrogen, so that the amount of air necessary to furnish 2 2-3 lbs. oxygen will be 2 2-3 ÷ .23, or 12 lbs. approximately. This, then, is the amount of air needed to just burn one pound of coal. Under actual conditions, however, much more than this must be supplied in order to provide sufficient draught, so that usually not less than about 20 lbs. is used, and with forced draught the figure will rise even above this.

The American Shipmasters' Association has changed its name to The American Bureau of Shipping. It was incorporated in 1862, and from a congregation of ships' officers has become an influential commercial body, hence the change of title.

Money to Burn?

Well, don't burn it that way, at least. Put on the "Heintz" Steam Trap wherever you have a pipe carrying steam from dryers, heaters, boilers, etc. It saves all waste steam. Even the smallest trap will discharge one gallon of hot water a minute. Operates on difference of one degree of temperature (211° to 212°), and is the only perfect trap made; the only one imitated. Its perfect action depends on a "tube spring" filled with a secret preparation, and the expansion of this spring makes the trap automatic, simple, long lived, perfect —20% to 30% of coal bills saved.

Inquiry will bring more information and some proofs. Ask for Booklet "G"



William S. Haines Company,

136 South Fourth Street, Philadelphia.

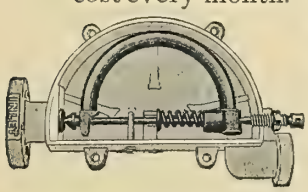
"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 3

Cents Burn Easily

as dollar bills when you buy good steam coal, make steam, and then blow it out of unprotected outlets. You save every drop of waste oil, why don't you save steam, too? The "Heintz" Steam Trap (some of the many imitations look like the original) saves every ounce of steam. It's quick acting and constant—works on a mechanical principle—not on faith or theory.

The smallest size discharges one gallon of water per minute; the largest, 240 gallons per minute, and not a puff of steam lost. The valve operates instantly on difference of one degree—211° to 212°—saves the cost every month. Our Booklet "G" for the asking.



William S. Haines Company,

136 South Fourth Street, Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 4

TRADE PUBLICATIONS.

Users of marine glasses should send to the Bausch & Lomb Optical Co., Rochester, N. Y., for a pocket size catalogue of the new stereo field glasses.

The International Anchor Co., Cleveland, O., has issued a 16-page catalogue with many illustrations of a new anchor, which has just been put on the market.

A little eight page catalogue is issued by L. W. Ferdinand & Co., 184 Federal St., Boston, Mass., illustrating and describing the Stentor megaphone, which is made especially for marine uses.

"Helps in Brazing" is the title of a 12-page catalogue just issued by the Joseph Dixon Crucible Co., Jersey City, N. J. It treats of the process of brazing, and gives much practical information. Copies can be had upon application.

A card 6 by 9 in. in size is issued by Putnam & Co., 150 Nassau St., New York, giving illustrations of a large variety of trucks, scales, etc. It includes a line of these which are especially adapted for use on steam vessels, wharves, etc.

Pipe-threading and cutting machines, made by D. Saunders' Sons, Yonkers, N. Y., are illustrated and described in a supplemental catalogue, which will be sent to all inquirers. Several types of machines are illustrated with large cuts, and full descriptions accompany them.

A catalogue is received from Patterson, Gottfried & Hunter, Ltd., 148 Center St., New York, descriptive of a line of machine tools, including lathes, grinders, polishing machines, etc., such as would be used in any metal working establishment. These include the products of some of the best makers.

The gate and other valves, expansion joints and other special appliances manufactured by the Coldwell-Wilcox Co., Newburgh,, N. Y., are well illustrated and described in a 5 by 9 in. catalogue just issued. Every user of steam appliances should send for a copy of this and preserve it for future reference.

The Stow flexible shaft, manufactured by the Stow Mfg. Co., Binghamton, N. Y., is thoroughly illustrated in all of its applications in catalogue No. 7, a copy of which can be had upon application and by mentioning this publication. This catalogue comprises over 50 pages and contains a large amount of interesting matter.

A sixteen page pamphlet regarding Daniel's Patent P. P. P. Diagonal Rod Packing has been received. It is printed in two colors and is a plain business talk regarding this packing, its special qualities and manner of using. Any user of packing cannot fail to benefit by a perusual. Copies can be had from C. A. Daniel, 409 Market St., Philadelphia, Pa.

Pier and dock building, together with dredging and harbor improvement work and other lines of engineering and contracting, are fully illustrated in an exceptionally handsome catalogue just received from the New York Dredging Co., World Building, New York. The catalogue is 6 by 9 in. in size, and has many full-page illustrations. It comprises 56 pages, and is a valuable book for reference on the subjects indicated.

Pneumatic tools manufactured by the Chicago Pneumatic Tool Co., 122 Liberty street, New York, are very finely illustrated and described in two catalogues. One is devoted to riveters, hammers and drills, and the other to boring machines, drills and pneumatic painting machines. Practically every tool illustrated is particularly adapted to marine work, and many of our readers will wish to send for copies of these catalogues.

BUSINESS NOTES.

PICTURE OF THE OREGON.—Every reader of Marine Engineering sending his name and address to the Peerless Rubber Mfg. Co., 16 Warren street, New York, will have sent to him free a large picture of the battle ship Oregon in four colors, 15 by 22 in. in size.

TRAVELING FREIGHT RAMP.—Handlers of freight between vessels and wharves will be much interested in the traveling ramp illustrated and described elsewhere in these pages. This device is one of the latest productions of the Link Belt Engineering Co., Nicetown, Philadelphia, Pa.

A COMPLETE SUPPLY HOUSE.—U. T. Hungerford, 121 Worth street, New York, has fitted up his new building from cellar to ceiling with everything in the line of brass and copper goods. He is now in shape to submit prices promptly, and to send catalogues and any other information regarding anything made in these two metals.

STOCKLESS ANCHORS.—Business is reported as brisk with the Baldt Anchor Co., Chester, Pa. The general type of these anchors can be seen from the cut in the advertisement on another page, and full information regarding them can be had by sending to the company for one of the very neat catalogues issued covering this subject.

THE OREGON'S FORGINGS.—The performance made by the battleship Oregon in steaming from San Francisco to Key West without a break-down in her machinery has won the admiration of engineers, and especially of those interested in marine machinery. The crank shafts, line shaft, thrust shaft and propeller shaft were all hollow forgings, having a 6-in. hole through them. They were manufactured by the Bethlehem Iron Co., South Bethlehem, Pa.

GARLOCK GASKETS.—Engineers who experience trouble with leaking man-hole and hand-hole plates should try the Garlock Cut Gasket. It is manufactured only by the Garlock Packing Co., Palmyra, N. Y. Prices and catalogues will be mailed on application to the main offices and factories, Palmyra, N. Y., or Rome, Ga., or from any of their salesrooms, New York, Boston, Philadelphia, Pittsburg, Cleveland, St. Louis, Denver. The Garlock Cut Gasket is also sold by the leading dealers everywhere.

MARINE ELECTRIC SETS.—The C & C Electric Co., 143 Liberty street, New York, has of late entered extensively into the production of generating sets, especially designed for steamship lighting, in which ironclad water-proof dynamos are used in direct connection with either a Case or a Forbes vertical engine. The company now has orders on file for quite a number of these combinations, prominent among them being two 15 K. W. sets for the United States Government, and sets ranging in capacity from 3 to 10 K. W. for the Boston Patrol Boat Co., Harlan & Hollingsworth Co., Wilmington, Del.; Weise Bros., Davenport, Ia., and others.

BEACON INCANDESCENT LAMPS.—For a number of years it has been the endeavor of lamp manufacturers to construct an incandescent lamp which will retain its initial candle power for the largest possible number of hours. It appears from numerous tests that the Beacon Lamp Co., of New Brunswick, N. J., has succeeded in producing a lamp that is claimed to retain its initial candle power for over 300 hours. The company is prepared to send lamps to any one desirous of making their own tests, free of expense, so that they may judge for themselves how the Beacon lamp compares with others. The standard efficiency guaranteed by the company is 3.5 watts per candle, but lamps are made from 2.75 watts upward.

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

AN OPPORTUNITY FOR MARINE ENGINEERS

AMERICAN SCHOOL OF CORRESPONDENCE

(Chartered by the Commonwealth of Massachusetts)

Offers a Thorough Course in

MARINE ENGINEERING.

We make a SPECIALTY of teaching Steam, Electrical and Mechanical Engineering.

Our COURSES are thorough and practical.

Our ADVISORY BOARD consists of experts of world-wide fame.

Our INSTRUCTORS are graduates of the best technical schools.

Our TERMS are low and within reach of every wage-earner.

Hundreds of ambitious ENGINEERS, ELECTRICIANS and MECHANICS have secured better positions and larger salaries through the up-to-date technical education received from our school. We have helped others and we can help YOU.

Special Offer to Readers of "Marine Engineering."

33 1/3% REDUCTION. For another 30 days we will **FOR 30 DAYS.**

continue to offer **33 1/3% REDUCTION** from our regular tuition fee to all readers of MARINE ENGINEERING. Write for our new handbook "N" containing schedules of courses, names of instructors, pages from instruction papers, etc.

AMERICAN SCHOOL OF CORRESPONDENCE,

BOSTON, MASS.

MARINE GLUE.—L. W. Ferdinand & Co., 184 Federal street, Boston, Mass., are sending out a circular regarding the genuine Jeffery's marine glue, of which they are sole American importers and agents.

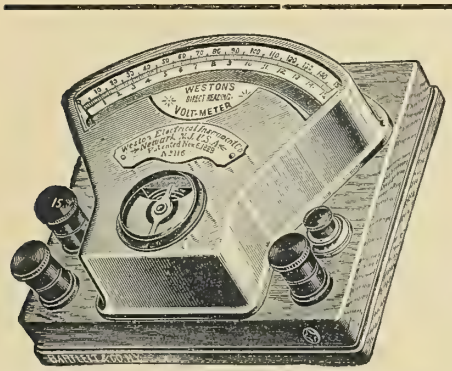
HOWDEN HOT DRAFT.—Two winters ago the Dry Dock Engine Works, Detroit, Mich., refitted the wooden steamer R. P. Ranney and installed the Howden draft apparatus. Some months later a letter was received from Chief Engineer James D. Stuart, saying: "We make a trip on 150 tons of $1.75 slack and always have all the steam we want. The Howden system has made a difference of from 35 to 50 tons of fuel on a trip and a difference of 35 cents a ton cost in favor of your boiler. * * * * * * I have no trouble at all chasing firemen; can take any kind of a man and he can make all the steam I want and in all conditions and with any kind of fuel." Pamphlets regarding the Howden system can be had by application to the Dry Dock company.

AN ACETYLENE SEARCH-LAMP.—Yachtsmen and owners of other craft will be interested in a powerful and inexpensive search light using acetylene gas, thus doing away with the necessity for fitting up with electrical apparatus. The light is made by J. B. Colt & Co., 3 to 7 West 29th street, New York, and is 14 in. dia., with a double reflector, which saves loss of light. It has both horizontal and vertical motion, and can be held rigidly in any position. It will make objects visible within a radius of hundreds of feet, and a newspaper, it is said, can be read over a thousand feet away. For any form of work at night this light is valuable. It can be mounted on any kind of a stand for contractors, lighting docks, vessels, etc. One generator only is required for several lights if near together, or for a number of lights for ordinary illuminating purposes in cabins, etc. The United States Government now uses this light in connection with range finders and for signal service.

WILLIAMS SUBMARINE COMPOUND.—After seven years' repeated use, the Red D Line SS. "Philadelphia" was taken to the Cramps' yard to be lengthened. A report says: "So well had the iron been protected that it was impossible to see the rivets or the least particle of rust on the plates." All the vessels of the Red D Line are painted with Williams submarine compound, and copies of a letter regarding the use of this can be had by sending to the manufacturer, Produce Exchange, New York.

ASBESTOS FIRE BOARD.—Professor Norton recently made a test of Asbestos Air Cell Fire Board to test its efficiency for protecting wooden surfaces, under the auspices of the Manufacturers' Mutual Fire Insurance Co. The report states that this fire board is not only remarkable as a non-conductor, but its durability and strength make it of much value for covering wooden surfaces. It is indestructible by fire and does not deteriorate with age. This board is made by the New York Asbestos Mfg. Co., 287 Douglass street, Brooklyn, N. Y.

RUBBERBESTOS GASKETS.—A. W. Chesterton & Co., 49 India street, Boston, Mass., are putting on the market a new line of gaskets made of rubberbestos. It is a new and improved sectional gasket, and the cut in the advertisement in this issue shows the form of coupling used. The gasket is similar to the hollow ones already on the market, the principal improvement being in the wire mesh, which is braided and incorporated on the inside, adding to the pressure resisting qualities. The material of which the gasket is made is the new compound rubberbestos. The ends of the coupling are larger in diameter than the center, and from its shape cannot easily be withdrawn after being once placed in position. The pressure on the plate pressing on the part of the gasket inside the head of the coupling forces it down on the coupling, thus making it impossible to blow out.



Weston Standard Portable Direct Reading Voltmeter.

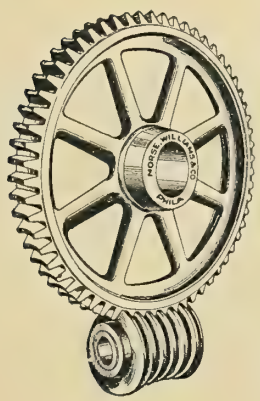
WESTON STANDARD PORTABLE

DIRECT READING

VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Intruments are recognized as **THE STANDARD** the world over. Our **VOLTMETERS** and **AMMETERS** are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.,
114-120 William St., NEWARK, N. J., U. S. A.



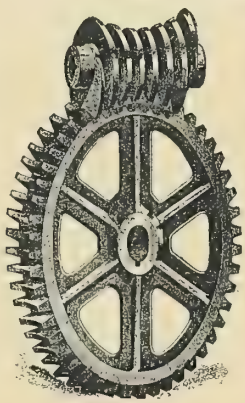
HINDLEY WORM GEARING

Is in general use in the machinery of modern vessels. Write for our descriptive circular, showing how this styte gearing gives THE BEST RESULTS.

MANUFACTURED BY

MORSE, WILLIAMS & CO.,
PHILADELPHIA, PA.

HINDLEY AND ALBRO



Worm Gearing

Consumes less power and gives better results than the old style worm gearing.

Albro-Clem Elevator Co.,
Philadelphia, Pa.,
U. S. A.

PROPELLER WHEELS.—The Sheriffs Mfg. Co., Milwaukee, Wis., recently shipped a 9 ft. propeller wheel to Montreal, Canada, and is reported to have received an order for a somewhat smaller wheel, to be shipped abroad through New York.

STEAM MOTOR.—The steam motor illustrated and mentioned in our advertising columns by James T. Halsey, Twenty-sixth and Callowhill Sts., Philadelphia, is especially designed for operating ventilating fans and for propelling boats. It needs no attention, and can be placed in any position. Full particulars regarding it can be had by applying to Mr. Halsey.

BRASS AND COPPER TUBING.—Users of seamless drawn brass and copper tubing; also other brass and copper goods, yellow metal, babbit and anti-friction metals would do well to send to Merchant & Co., 517 Arch street, Philadelphia, Pa., for catalogues and other information. This company makes a specialty of this line of goods, and has branch offices in various parts of the country.

CORRESPONDENCE INSTRUCTION.—Rapid strides have been made of late years in the matter of instruction by correspondence, and eminent among the institutions teaching in this manner are the International Correspondence Schools, P. O. Box 1111, Scranton, Pa. The school was established in 1891, and now has special departments in all branches of engineering, being especially strong in all branches of marine work. Full information concerning the various courses can be had upon application.

THE PARAGON BOILER.—The Paragon boiler has been given a practical test on the canal steamer Arthur D. Bissell. This steamer, carrying 135 gross tons, has towed five heavily loaded consorts from New York to Buffalo. The combined tonnage of the freight was 915 tons, and the boats averaged 60 tons, making the total weight of boats and cargoes 1,275 tons. With this tow the steamer burned only 1½ tons of coal per 24 hours, so we are informed by Captain M. De Puy, 19 South street, New York. The captain is now building a steamer named the "Paragon," which is just being put into commission.

ELECTRICAL MACHINERY.—A complete line of electrical machinery for all uses is made by the Westinghouse Electrical & Mfg. Co., Pittsburg, Pa. For use on steam vessels this company offers an electric set comprising a Westinghouse dynamo direct connected to a Westinghouse engine, making one of the most complete sets built. In regard to electric motors, an exceptionally handsome catalogue has just been published, entitled "Electricity for Machine Driving," which will be sent to all readers of Marine Engineering writing for them. Another catalogue of unusual interest is entitled "Quarter of a Million Horse Power." There is much information in both catalogues regarding the great electric power plant at Niagara Falls. Copies of these catalogues can be had upon application to the company.

ICE MACHINES FOR THE NAVY.—The steamships Pennsylvania and Illinois, recently sold by the International Navigation Co. to the government are equipped with refrigerating plants made by the Kilbourn Construction Co. It is only necessary to run one of these plants seven hours per day, a small 5 by 10 in. Compressor doing the work. A cold storage machine of the type mentioned has the following dimensions: Compressor—Cylinder, 5 in. dia. by 10 in. stroke; at 60 rev. (minimum) displaces 23,556 cu. in. of gas; 3.36 tons refrigeration; 954,240 B. T. U.; 9,542 cu. ft. refrigeration. At 120 rev. (maximum) 47,112 cu. in. displacement; 6.73 tons refrigeration; 1911.320 B. T. U.; 19,113 cu. ft. refrigeration. Engine—Horse power required to drive compressor, at 60 rev., 3.57; at 120 rev., 7.14. This plant occupies but 10 ft. square, grouped.

GOVERNMENT SPECIFICATIONS.

The United States Government, especially the Navy Department, is a believer in paint, both as a preservative and for its beautifying qualities. Having at its command the services of the most experienced experts, it indulges in no theories and tolerates no sentiment in the selection of materials; but patiently determines what is best for a given purpose, and then orders the use of exactly that material.

To paint users in general the specifications and practice of the Government are, therefore, interesting and enlightening. Of special importance is the fact that wherever paint is to be exposed to the action of salt water or sea air, zinc white is an essential ingredient. An official at one of the largest navy yards being asked recently by a large bidder for supplies, "What do you do with all the zinc white shipped you?" answered, "We use it in everything; even in red lead."

Similar testimony is offered in the specifications for the U. S. Lighthouse Establishment, which read as follows:

White Paint:

"American white lead and American white zinc dry in proportions of ¼ of the former to ¾ of the latter.

"*White* turpentine liquid drier.

"*Refined* linseed oil."

Cream-Color and Straw-Color Paints:

"Base to best American white zinc.

"English yellow ocher.

"Turpentine liquid drier.

"Refined linseed oil.

"The colored paints are wanted for outside use, and are required to withstand the bleaching effects of salt water and sunlight."

Zinc White is the one white paint material which is capable of resisting salt water and salt air; there is no other pigment fit for use under all conditions of marine service. Added to other materials it gives them durability.

THE NEW JERSEY ZINC COMPANY.

REDUCING VALVES

to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,

BOSTON, MASS.

PATENTS SECURED.

Inventors desiring to secure full information in regard to the necessary course to pursue to obtain a patent, should send for our booklet on the subject.

MAILED FREE TO ANY ADDRESS.

PATENT DEPARTMENT:

THE POWER PUBLISHING CO.,

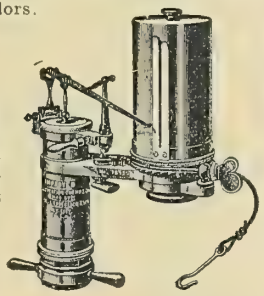
WORLD BUILDING, NEW YORK.

SEND 2 LABELS

cut from front of boxes of EUREKA PACKING and we will send you a pack of beautiful playing cards. All being special in 3 colors.

MARINE ENGINEERS

should own an INDICATOR and know how to use it. Send for circular and *special* prices. It will interest you.



Jas. L. Robertson & Son,
218 Fulton St., N. Y.

H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.
Manufacturer of **Screw Propellers** for Usual and for Special Work.
The Allen Dense Air Ice Machine for Steam Vessels.
41 MAIDEN LANE, NEW YORK.

THE NEW HAVEN LINE.

The famous boats Richard Peck and C H. Northam afford the only service by water between New York and New Haven, reaching New Haven in plenty of time in the morning to make connections by rail for any part of New England.
E. F. DEYOUNG, Treasurer and Agent,
Piers 25 and 26, East River, New York.

LINENOID GOODS.—A small launch which is seamless and made of linenoid is being put on the market by Crane Bros., Westfield, Mass. A small gasolene engine furnishes the motive power, and for such uses as yacht tenders, etc., it is proving very popular.

BOILER GASKETS.—The boilers of the New Haven steamer Richard Peck are fitted with Excelsior boiler gaskets, manufactured by the Boston Belting Co., Boston, Mass. Chief Engineer Macdonald, of the steamer, in writing to the manufacturer, says: "We have had them in use four years and have compared them with about every other kind of gasket, and have found them, when used in connection with steam at 160 lbs., to give better results and be more durable and economical than any gaskets we have used."

STOREY MOTORS.—Owing to the great increase in business the Storey Motor & Tool Co. has removed from Philadelphia to 464 So. Broad St., Trenton, N. J., with the Trenton Iron Co. The new quarters give largely increased facilities for the manufacturers of the Storey multipolar enclosed dust-and-moisture-proof motors, which have already established their reputation. These motors are light in weight, and can be arranged for slow speed and adapted for almost any class of work. Information can be had by applying to the company.

Extra Heavy Gate Valves

FOR HIGH PRESSURE STEAM.

Balanced Expansion Joints and Flanged Fittings.
Send for Catalogue.
COLDWELL-WILCOX CO., Newburgh, N.Y.

Electricity for Marine Engineers

Every intelligent engineer appreciates the fact that a working knowledge of electrical engineering has now become one of the conditions upon which many of the best positions depend.

Our Junior Course in Electrical Engineering

meets this want. For our handsome illustrated FREE book entitled **"Can I Become An Electrical Engineer?"** address

The Electrical Engineer Institute of Correspondence Instruction

120 Liberty St., New York, U. S. A.

Endorsed by Every Prominent Electrical Engineer

HERMAN A. STRAUSS, E. E., General Manager

RAINBOW PACKING

Makes a Steam Joint Instantly.

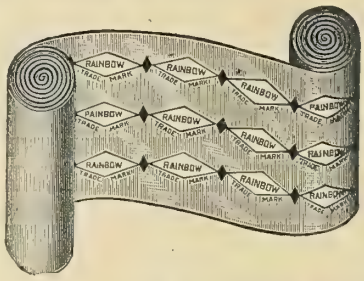
HONEST JOHN.

MR. JOHN H. DEMING.
General Superintendent Peerless Rubber Manufacturing Co.

THE COLOR OF RAINBOW IS RED.

NOT AFFECTED BY OILS, AMMONIA LIQUORS, STEAM HEAT OR ALKALIES.

None genuine without the Trade-Mark.



RAINBOW PACKING HAS 3 ROWS OF DIAMONDS IN BLACK EXTENDING THROUGHOUT THE ENTIRE LENGTH OF EACH AND EVERY ROLL.

Fac-simile of a Roll of Rainbow Packing.

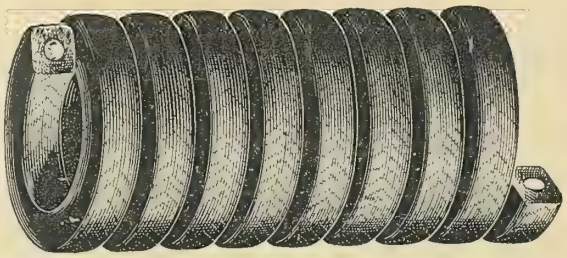
Who invented and who is the only man in the world who can make or ever has made

Rainbow Packing.

RAINBOW GASKETS are especially adapted for Low Pressure Steam and Hot Water Heating Apparatus.

PEERLESS DISCS for Russell, Frink, Walworth, Jenkins, Lorain and Kelly & Jones Valves.

"HONEST JOHN."



Made in both Straight and Spiral Form.

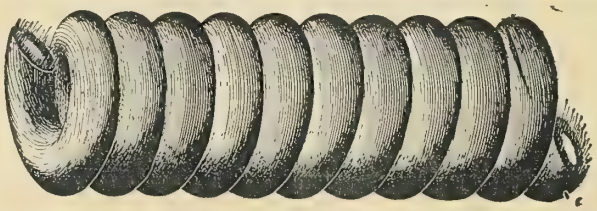
Once Tried, Always Used.

Put up in Boxes.

HYDRAULIC RAINBOW CORE PACKING.

The Best Hydraulic and Cold Water Packing in the World.

Hercules Combination.



Always Tight. Leaves the Stem Clean.

Will Hold 400 lbs. Steam.

Metallic Stop Valve Packing.

SEND FOR CATALOGUE.

Patented, Copyrighted and Manufactured Exclusively by

THE PEERLESS RUBBER MANUFACTURING CO.,

16 Warren Street, New York.

16-24 Woodward Ave., Detroit, Mich. 202-210 So. Water St., Chicago, Ill.
17-19 Beale St., and 18-24 Main St., San Francisco, California.

HOWDEN HOT DRAFT.

TOTAL INSTALLATIONS THROUGHOUT THE WORLD,

724 Steamers--1,830,100 Horse Power.

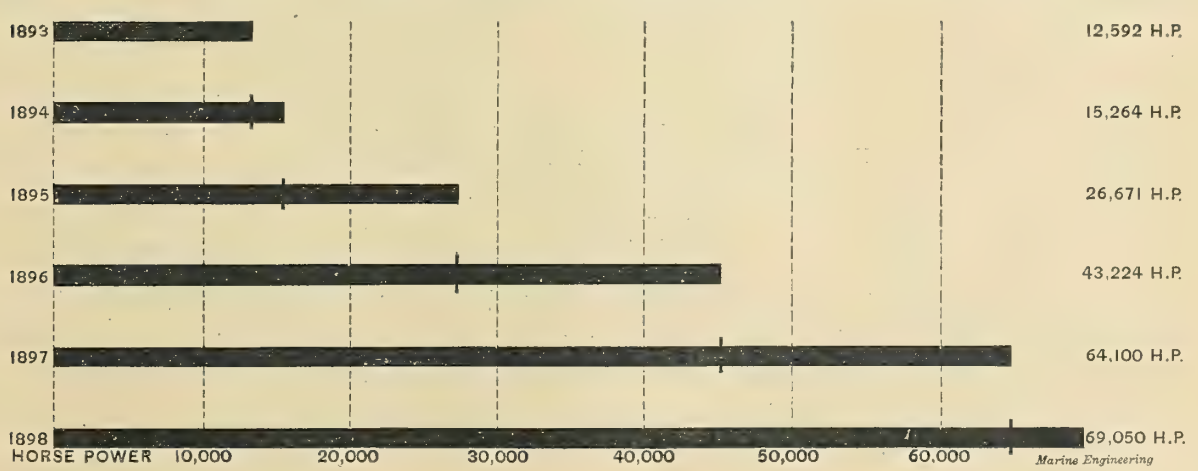
TOTAL INSTALLATIONS BY THE

Dry Dock Engine Works, Detroit, Mich.,

56 STEAMERS--69,050 HORSE POWER.

The engine and blower for supplying the draft can be placed in any convenient place, preferably in the engine room. The hot air from the engine room is taken in and forced through the air heater, where it is heated by passing among vertical tubes, through which the escaping gases from the boiler pass. The heated air is led down in ducts around the breeching and delivered under and over the grates in sufficient quantities to get perfect combustion. This is the general principle of the Howden system.

Diagram showing the increase of HOWDEN equipments by us for the first six years.



The Only AUTOMATIC Injector IN THE WORLD

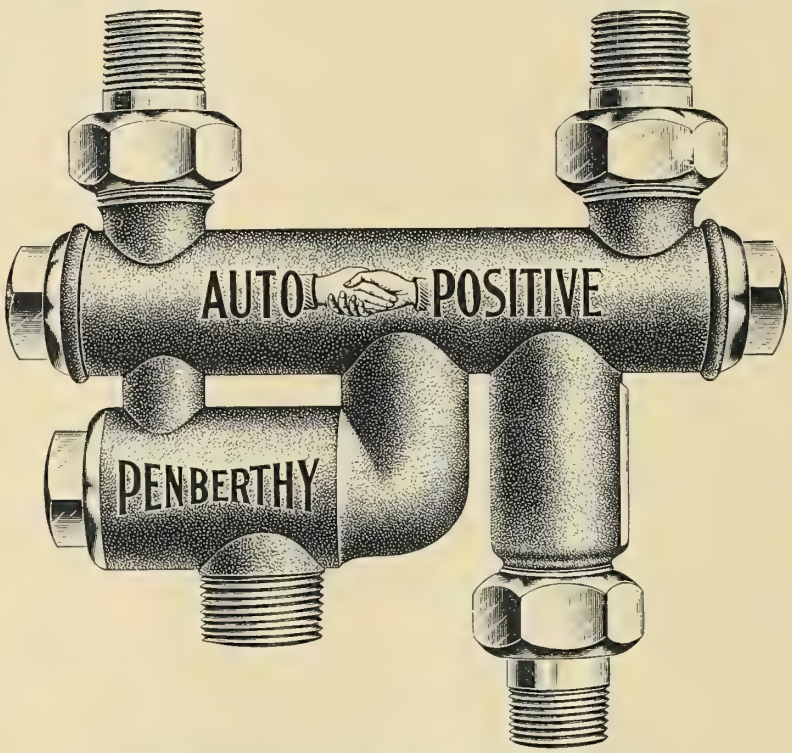
WHICH WILL START Low at 15 to 18 lbs. Steam,
Work High at 225 to 235 lbs. Steam,
Lift Water 20 to 22 ft., at 60 to 100 lbs. Steam,
Handle Hot Water at 140 to 143 degrees, at 75 to 100 lbs. Steam,

IS THE AUTO - POSITIVE

TRADE PENBERTHY MARK.

ONLY SIX WORKING PARTS

A MARVEL OF SIMPLICITY



HIGH PRESSURE AND HOT WATER INJECTOR.

AUTOMATIC IN ACTION.
POSITIVE IN RESULTS.

Especially Adapted for Marine and Water Tube Boilers.

PENBERTHY INJECTOR CO.

115 Seventh Street, Detroit, Mich.

GARLOCK'S HIGH-GRADE PACKINGS.

Send for Samples and New Catalogue.

The Standard for 18 Years, and Hold the Record for Quality, Durability and Economy.

GARLOCK'S GASKETS AND RINGS. Superior to all others. Our standard grades are the Garlock Gasket, the Economical Gasket, the Achilles Gasket. Engineers and dealers will find it to their interest to correspond with us as to prices, for we guarantee to save you money.

CUT GASKETS for Man-Holes and Hand-Holes.

THE GARLOCK PACKING CO.

New York, Boston, Chicago, Philadelphia,
Pittsburg, Cleveland, St. Louis, Denver.

They are the Ideal Packings . for Steam, Water, . . Gas, Ammonia, ... Etc.

Main Offices and Factories : PALMYRA, N. Y.; ROME, GA.

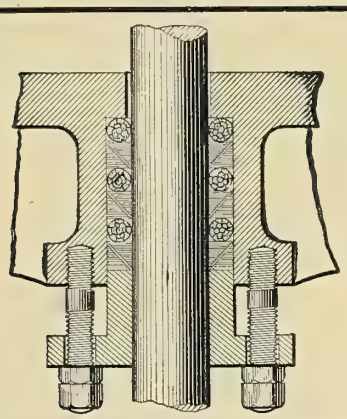


Fig. 1—Packing in position and gland adjusted

DANIEL'S PATENT P. P. P.

Diagonal Rod Packing.

The most elastic and durable packing for feed pumps, air pumps, hydraulic pumps, and trunk plunger pumps, also for electric engines and all other auxiliary engines and pumps. Special grades for high steam pressures on main engine rods and valve stems, also for ammonia compression pump rods.

Send for sample. Will not score the rods. Manufactured only by

C. A. DANIEL,

409 Market St., Philadelphia, Pa.

Branch Offices: Pittsburg, 105 Water St.; San Francisco, 514 Mission St.; Chicago, 4 S. Canal St.; Toledo, 638 Leonard St.

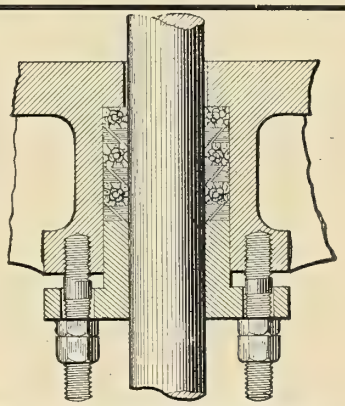


Fig. 2—Gland screwed down, showing how the wedges slide up to compensate for wear.

NORTHERN STEAMSHIP CO.

Office of the Agent.

Buffalo, N.Y. Oct., 8, 1897.

Regal Packing Co.,

Chicago, Ill.

Gentlemen:-

Replying to your inquiry as to the merits of your Regal Metallic packing as shown by its use on the Engines and other machinery of the Steamship North West, it gives me pleasure to report that it is giving unqualified satisfaction in every place where it has been applied.

We are now using it in the stuffing boxes on one of our main Quadruple Expansion Engines (of 3000 H.P.), as well as in our pumps, injectors, etc., which operate in connection with our Belleville Boilers, and also in other places where packing of unusual character is required against high pressures, or to endure severe service either for water or steam.

We carry 267 lbs. boiler pressure and steam at 200 lbs. is delivered to our high pressure cylinders. This will afford some idea of the character of the packing we require, and I am pleased to state that your Regal Packing has met this demand perfectly.

As a matter very important to Engineers, your packing contains a lubricating element which is constant, and for that reason there is a very appreciable reduction in the amount of friction on all rods and stems and a consequent reduction in the amount of wear thereon.

I sincerely believe your Regal Metallic packing superior to anything I have known and its economy is unquestioned since it can be used over and over again for all time. I have nothing but good words for it, and I am sure every Engineer will use nothing else when once its value is understood.

Very truly yours,

I take pleasure in endorsing the above Miers Coryell

John A. Currier

Chief Engineer

Str. North West.

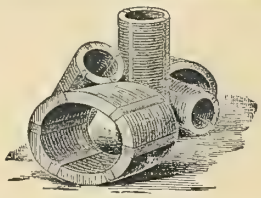
REGAL Metallic Packing.

Descriptive booklet sent on application.

Regal Packing Company,

Fisher Building, Chicago, Ill.

GASKETS.



ANY SIZE OR SHAPE, FOR THE SMALLEST HAND HOLE OR THE LARGEST CYLINDER TOP. : : : :

Our various grades of stock are adapted for any and all kinds of joints, and will give entire satisfaction under the highest pressures and most severe conditions.

BOSTON BELTING CO.

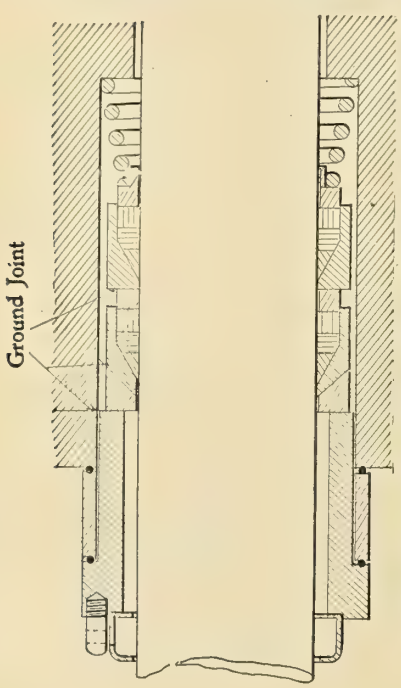
JAMES BENNETT FORSYTH,
Mfg. Agt. and Gen. Mgr.,
Manufacturers of
BELTING, HOSE, PACKING, VALVES AND RUBBER GOODS
of the Best Quality.

BOSTON: 256-260 Devonshire St.
NEW YORK: 100 Reade St.
BUFFALO: 90 Pearl St.
CHICAGO: 109 Madison St.
SAN FRANCISCO: 24 Fremont St.
NEW ORLEANS: 316-318 St. Charles St.

METALLIC PACKING

a necessity in Marine practice and

The United States is the best

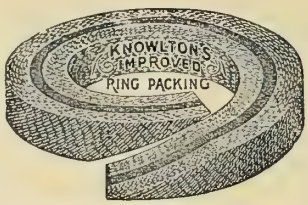


packing in the world.

It is in use on steam vessels in all parts of the globe.

Over 90,000 in use.

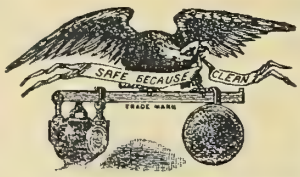
The United States Metallic Packing Co.,
427 N. 13th Street,
Philadelphia, Pa.



No Rubber on the Rod. A Cushion in the Right Place.

KNOWLTON PACKING CO.,
19 Pearl St., BOSTON, MASS.

THOS. C. WARLEY & CO., *Manufacturers of*
BOILER CLEANSING COMPOUNDS



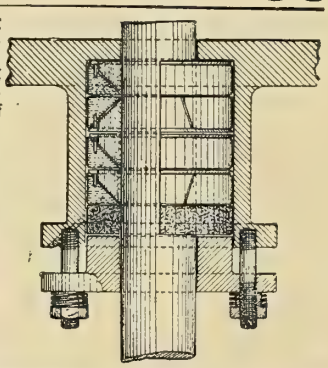
Main Office: No. 11 So. Ninth St.,
P. O. Box 1262. Philadelphia, Pa.

These Compounds are unequalled. They give satisfaction where others fail. They are especially adapted for use in Marine Steam Plants. Write for Descriptive Circular.

KATZENSTEIN'S
METALLIC PACKINGS

Of different designs for stuffing boxes of engines, pumps, etc.

Flexible Tubular Metallic Packing for Slip Joints on Steam Pipes.
Metallic Gaskets for all kinds of Flanges.
Highest Grade Anti-Friction Metal for Bearings.
Patent Automatic Life Boat Detacher.
Patent Duplex Water Tight Compartment Doors.



L. KATZENSTEIN & CO.,
General Machinists' and Engineers' Supplies, : :
357 WEST ST., NEW YORK, U. S. A.

RANDOLPH BRANDT,

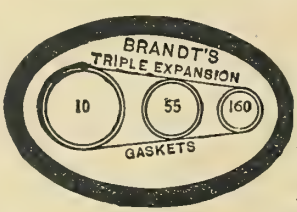
38 Cortlandt Street, New York.

SPECIALTIES.

SELDEN'S PATENT PACKINGS

are made either with a rubber core or a canvas core and will keep stuffing boxes tight with less friction than any other packing.

BRANDT'S TRIPLE EXPANSION GASKETS

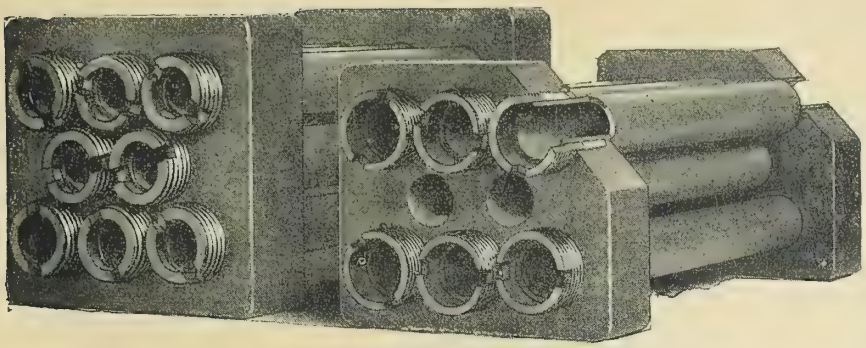


are the best man-hole and hand-hole gaskets for high pressures.

BRANDT'S PUMP VALVES will stand hot water and oils.

The best grades of **Rubber Hose, Joint Packings** and other **Engineers' Stores.**

Orders filled promptly and satisfaction guaranteed. Your trade is solicited.



IMPROVED LIGHTHALL

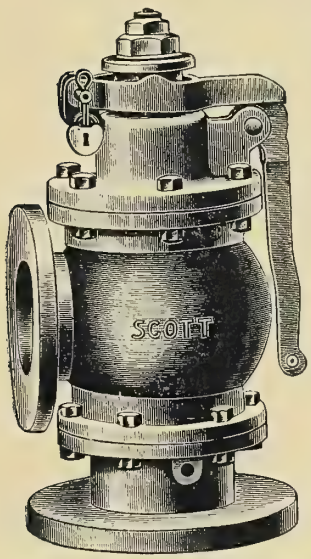
Surface Condenser

with Cobb's patent system of aligning, securing and packing condenser tubes in tube heads. Condenser supplies and repairs at short notice.

D. McLEOD COBB, Huntington and Smith Sts., Brooklyn, N.Y.

Formerly SOUTH BROOKLYN STEAM ENGINE WORKS. New York Office, 38 Burling Slip.

SCOTT Improved Marine Lock Up "Pop" SAFETY VALVE



Adopted by the Board of Supervising Inspectors held at Washington, D. C., in 1892, for marine use.

Most reliable and sensitive in use.

Entirely frictionless.

Cannot cock, tilt or stick to seat.

Opens precisely at fixed working pressure, allowing no excess above that limit.

Send for Catalogue describing its superior points.

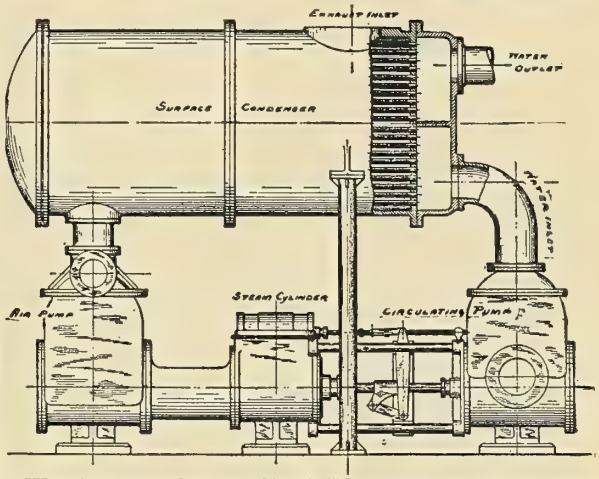
ROE STEPHENS MFG. COMPANY

Detroit, Mich., U. S. A.

WAINWRIGHT CORRUGATED TUBE SURFACE CONDENSERS,

10 to 2,000 Square Feet of Surface.

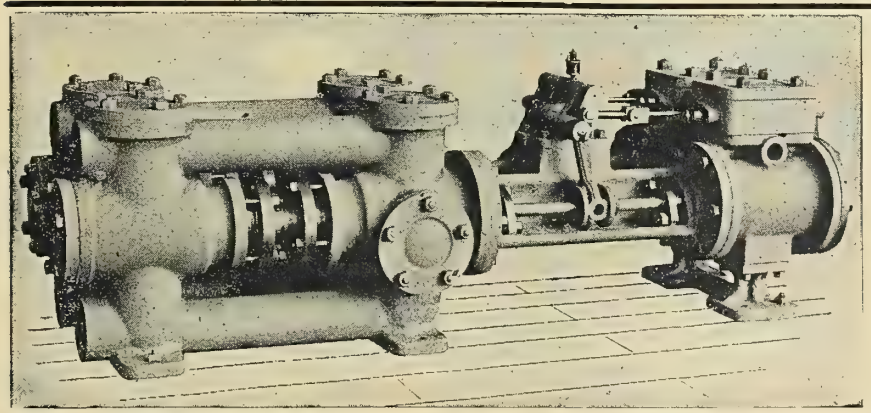
No paper ferrules. No corset-lacing packing. Tubes fastened at each end with brass thimbles. Absolute freedom from leaky joints.



We also manufacture Feed Water Heaters, Expansion Joints, Corrugated Copper Gaskets, etc.

Taunton Locomotive Manufacturing Co.,

TAUNTON, MASS.



THE HUGHES IMPROVED DUPLEX PLUNGER PUMPS

Are extra strong, compact and durable. They are externally packed and are particularly well adapted for marine service. Catalogue showing different styles will be sent on application.

THE SNIDER-HUGHES CO., COE AND HAMILTON STREETS, CLEVELAND, O.

THE GRAPHITE LUBRICATING CO.,

BOUND BROOK, N. J., U. S. A.,

MANUFACTURERS OF

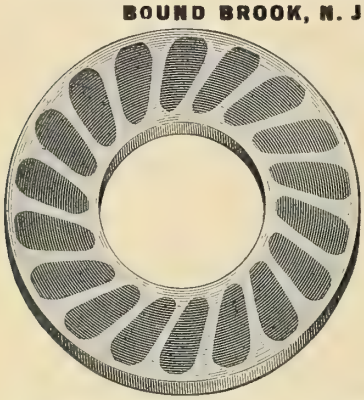
PATENT

Graphite and Bronze

BUSHINGS, BEARINGS AND WASHERS.

For all kinds of

Machinery, Hoisting Apparatus, Tackle Blocks, Etc., Etc.



Can be used with or without Oil.

IMPERIAL METAL POLISH.

IMPERIAL
METAL
POLISH.
EASILY APPLIED.
RADIANT IN LUSTRE.
INSTANTANEOUS IN ACTION.
ALL METALS, HOT OR COLD.
LIQUID OR PASTE.

MADE BY

THE RATH MANUFACTURING CO.

New York—Philadelphia.

18 and 20 Liberty Street, NEW YORK CITY.

Hancock, Laurel & Second Sts., PHILA., PA.

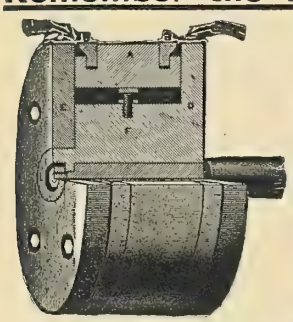
NEW YORK OFFICE:

WILLIAM E. BURTON, Manager.

EXPORT DEP'T.

FREDERICK W. KRISTELLER.

Remember the name IMPERIAL.



SELF-ADJUSTING STEAM CYLINDER PACKING

for **STEAMSHIP, YACHT, TUGBOAT,** and all classes of **ENGINES,** high and low pressure.

Makes piston perfectly tight with minimum of friction. Increases revolutions of wheel, saves fuel, secures true cylinder. Owing to its immediate action, engines can be started, stopped, or reversed instantly. Used in the engines of the leading Steam Yachts and Vessels.

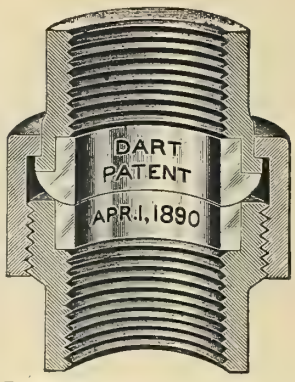
We guarantee no leakage of Steam over piston.

Manufactured and licenses granted to manufacture under our patents by

THE ST. JOHN CYLINDER PACKING CO.

General Offices: 108 Fulton Street, N. Y. City, N. Y.

SHELDON H. BASSETT, Gen'l Agt.



THE BEST UNION

Made in the U. S.

M'f'd by the

E. M. DART MFG. CO.

Providence, R. I.

Send for Circulars and Prices.

Marine Engineering Taught by Mail.

Studies are carried on without loss of time from work. Thorough instruction under the direction of able engineers. Students on many vessels of the United States Navy endorse our methods. The course in Marine Engineering is designed to qualify Engineers to pass all examinations required in the United States Merchant Marine, and to enable Oilers, Water Tenders, Firemen and Coal Passers to qualify for Third Assistant Engineers' licenses.

Courses by Mail

in all branches of Steam Engineering, Civil Engineering, Electrical Engineering and Mechanical Drawing.

Send for free circular. Mention subject in which you are interested. Address

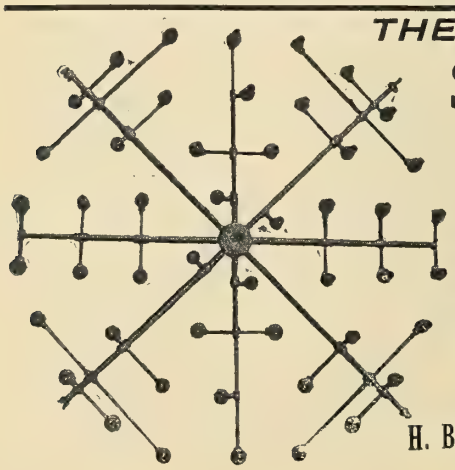
The International Correspondence Schools,

Box 1111, SCRANTON, PA.

THE IMPROVED ANNULAR

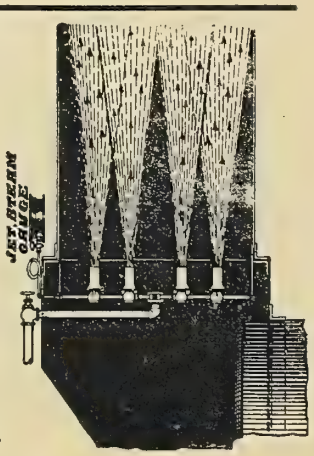
STEAM JET.

POWERFUL—ECONOMICAL.



Gives draft equal to a fan. Can be applied to any stack, and will greatly increase the draft with a minimum amount of steam. Cuts show section of a jet and spider to which they are attached.

Send for circulars and list of steamers on which it is used.

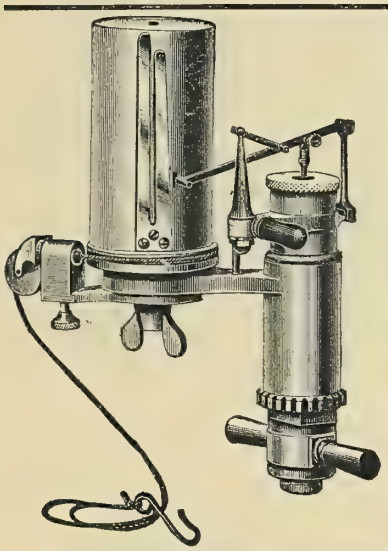


H. BLOOMSBURG & CO., NEWPORT NEWS, VA.

The **CROSS OIL FILTER**

actually reduces oil bills 50% or more. Sent on approval. Used in 17 countries. Adapted to steam vessels of every description. Send for circulars, testimonials, etc.

THE BURT MANUFACTURING CO.
AKRON, OHIO, U. S. A.
The Largest Manufacturers of Oil Filters in the World.



AMERICAN THOMPSON IMPROVED INDICATOR.

ORIGINAL THOMPSON INDICATOR.

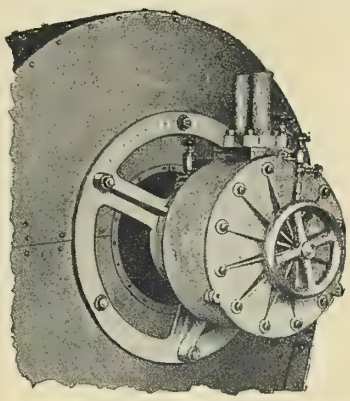
Ideal Reducing Wheel, Pantograph and Planimeter.

BOURDON & LANE'S PRESSURE AND VACUUM GAUGES.

AMERICAN POP SAFETY VALVE.

AMERICAN STEAM GAUGE CO.,
34-36-38 Chardon St.,
Chicago **BOSTON, MASS.** New York
SEND FOR CATALOGUE F.

STEAM MOTORS
FOR
Forced Draft Fans and Driving Boats.



Require no attention.
Used on the American Line 3 years.
Not a rotary engine,
500 to 2,000 revolutions per minute.
Single expansion or compound.
Economy guaranteed.

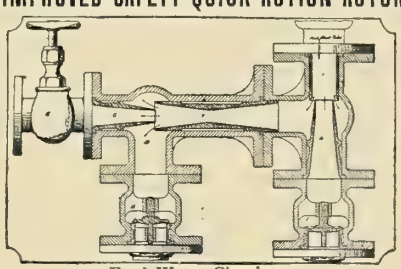
JAMES T. HALSEY,
26th and CALLOWHILL STS.,
PHILADELPHIA, PA.

IMPORTANT FOR SHIPBUILDING CONCERNS.

CONSTRUCTION OF STEAM ENGINES, GAS AND WATER CONDUITS.

For sale, the Patent for the United States of a very successful invention concerning the construction of Steam, Water, Gas, Etc., Conduits, with the greatest power of resistance against very high pressure. Apply to N. G., 1888, care of New York Herald, New York.

Craig's Steam, Vacuum and Hydraulic Specialties,
Consisting of PATENT
IMPROVED SAFETY QUICK-ACTION AUTOMATIC STOP VALVES,



Feed Water Circulator.

For Pipes of all kinds under Pressure, for Steam, Water or any other fluid.

IMPROVED AUTOMATIC EXHAUST RELIEF VALVES,
For Condensing and Non-condensing Engines, Marine or Stationary.

HEATING and CIRCULATING APPARATUS for STEAM BOILERS.

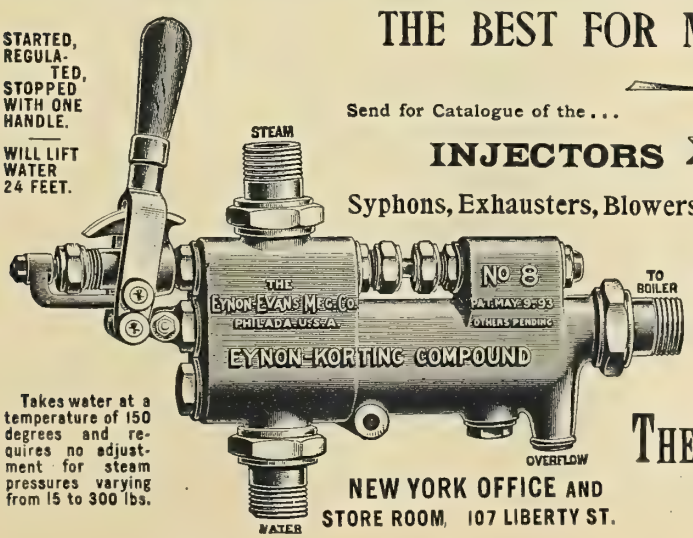
ADDRESS
WILLIAM CRAIG, 121 Liberty St., New York.

Eynon-Korting Compound Injector.

THE BEST FOR MARINE, LOCOMOTIVE AND STATIONARY BOILERS.

STARTED, REGULATED, STOPPED WITH ONE HANDLE.

WILL LIFT WATER 24 FEET.



Takes water at a temperature of 150 degrees and requires no adjustment for steam pressures varying from 15 to 300 lbs.

Send for Catalogue of the...

INJECTORS **CONDENSERS**

Syphons, Exhausters, Blowers, Ventilators, Blast Nozzles, Bilge-Pumps, Etc.

BRONZE FOUNDRY DEPARTMENT:
Copper Castings, Phosphor and Manganese Bronze, Red and Yellow Brass Castings.
Capacity 10,000 lbs. per heat.

THE EYNON-EVANS MFG. CO.,
1513 Clearfield Street,
Philadelphia, Pa.

NEW YORK OFFICE AND STORE ROOM, 107 LIBERTY ST.

W. P. PHILLIPS & CO.,

MANUFACTURERS OF

OIL CUPS,
LUBRICATORS,
GREASE CUPS

—AND—

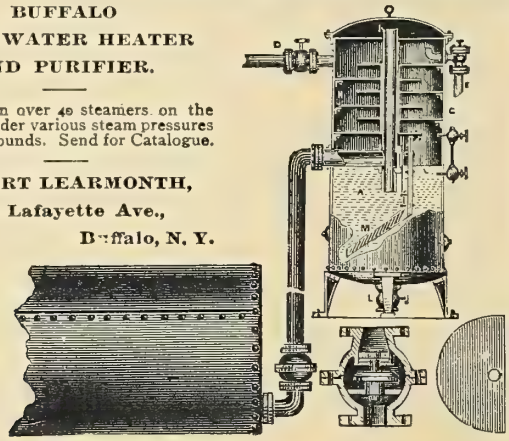
ENGINEERS' SPECIALTIES,

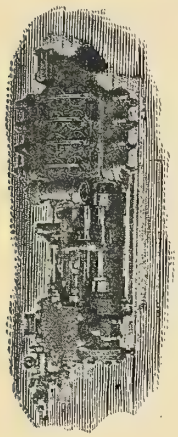
No. 71 Sudbury St., BOSTON, MASS.

BUFFALO
FEED WATER HEATER
AND PURIFIER.

In use on over 40 steamers on the lakes. Under various steam pressures up to 250 pounds. Send for Catalogue.

ROBERT LEARMONTH,
200 Lafayette Ave.,
Buffalo, N. Y.





The SNOW Steam Pump Works,

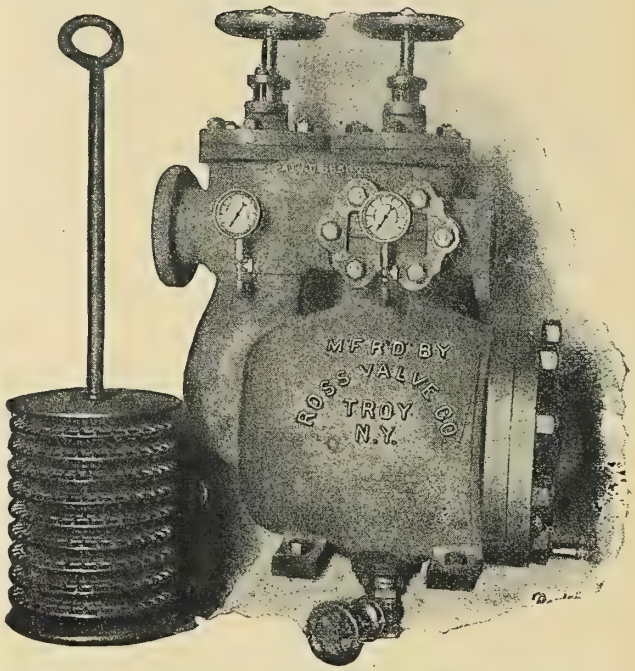
BUFFALO, N. Y.

Marine Pumps

FOR ALL SERVICES.

New York: 126 Liberty Street.
Philadelphia: 506 Drexel Building.
London: 98 Leadenhall Street.

KEEP OIL OUT OF YOUR BOILER



BY USING THE ROSS FEED WATER FILTER.

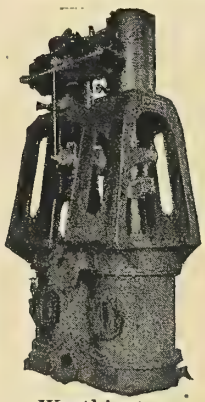
For all Particulars, Address

THE ROSS VALVE CO.,

TROY, N. Y.

Don't Be Misled

into purchasing any marine pumps without first investigating those manufactured by us. The Worthington Twin Cylinder Vertical Beam Air Pump is the latest and most approved form of air pump introduced to the marine world, and has become the recognized leader of its class. The more recent battleships of the United States Navy and the cruisers of the Navy of Japan are fitted with these machines, and with pumps of our make for boiler feeding and general hydraulic purposes.



Worthington Vertical Beam Air Pump.

The Worthington Admiralty Pump was especially designed to meet the requirements of the British Admiralty and the views of the United States Bureau of Steam Engineering. It is a machine that occupies the least possible floor space and is of the lightest weight commensurate with proper strength. All of its parts are easy of access and constructed of the best possible quality of material.

The special experts in charge of our Marine Pump Department will be glad to correspond with engineers regarding this particular service and supply estimates if desired. Illustrated Catalogues will be sent for the asking.

NEW YORK, CHICAGO, BOSTON, ST. LOUIS, CLEVELAND,

HENRY R. WORTHINGTON,

724 ARCH ST.,
PHILADELPHIA, PA.

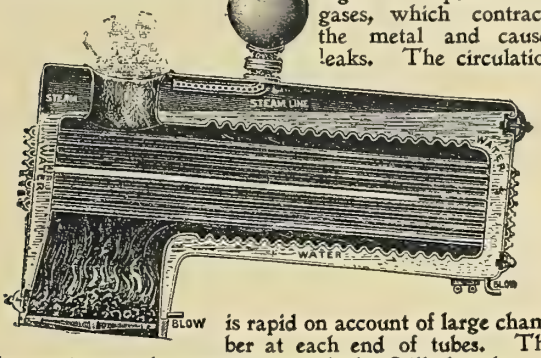
ATLANTA, PITTSBURG NEW ORLEANS, SAN FRANCISCO BUTTE.

THE TONKIN PATENT

INTERNALLY FIRED WATER-TUBE BOILER

For Marine or any Purpose where Steam is Required.

Soot can be blown from the tubes in this boiler without opening doors into the furnace, and lowering the temperature of gases, which contracts the metal and causes leaks. The circulation



is rapid on account of large chamber at each end of tubes. The boilers are in use where water is very bad. Still, the tubes are kept clean by the rapid circulation.

Eight tests showed from 11.985 to 14.660 pounds of water evaporated per pound of combustible from and at 212° F. We can save money for you.

Adapted to any pressure up to 500 pounds.

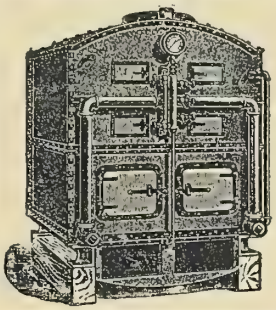
JOHN EATON,
President Oil Well Supply Co.,
PITTSBURG, PA.

JOHN J. TONKIN,
Room 609, Havemeyer Bldg.
26 CORTLANDT ST., N. Y.

BRANCH OFFICES:
15 Federal Street, Boston, Mass., W. H. Bailey, Manager.
54 Manufacturers' Record Bldg., Baltimore, Md., John H. Buxton, Manager.

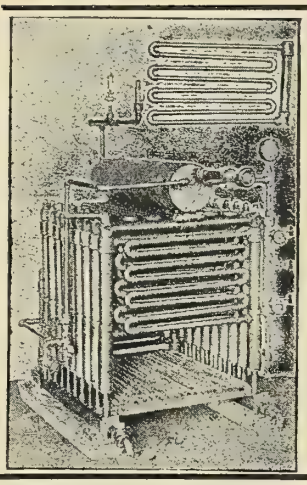
CLARK'S PATENT SAFETY WATER TUBE BOILER.

For MARINE and STATIONARY WORK.



Now Used in a Number of Yachts, Launches and Passenger Steamers.

MANUFACTURED BY
EDWARD S. CLARK,
Nos. 272-278 Freeport St.,
Harrison Sq., Boston, Mass.



THE BUCKLEY PATENT

SAFETY WATER TUBE BOILER

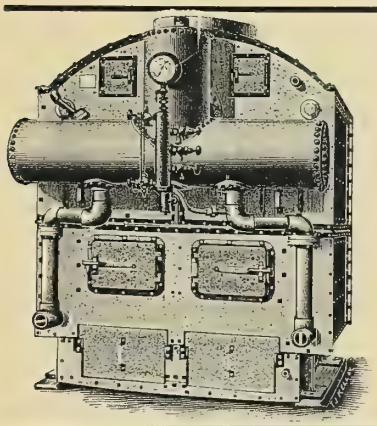
FOR

Boats and Yachts.

No Left Hand Threads in this Boiler.

For Catalogue and Prices address

ROCHESTER MACHINE TOOL WORKS,
20 Frank Street,
ROCHESTER, N. Y.



ALMY WATER-TUBE BOILER CO.

MANUFACTURERS OF

Almy's Patent Sectional Water-Tube Boilers

For Marine and Stationary Work,

Nos. 178 TO 184 ALLENS AVENUE
(Between Rhodes and Public Streets),

TAKE EDDY ST. CAR.
LONG DISTANCE TELEPHONE.

PROVIDENCE, R. I.

KINGSFORD BOILER WORKS, *OSWEGO, N. Y.*

Marine Boilers of every description designed and constructed on short notice. Estimates given.

Best Material.
High Class Workmanship.
Reasonable Prices.

Special Types of Marine Boilers for Steam Yachts, Passenger Steamers, and Tugs.

Kingsford Foundry and Machine Works,
OSWEGO, N. Y.

Seamless Cold Drawn Steel Boiler Tubes

FOR HIGH PRESSURES AND EXCESS DUTY

....MANUFACTURED FROM....

SOLID ROUND BAR—NO LAPS, SEAMS OR WELDS.

Cold Drawn Finish and Density of Metal prevent pitting and corroding.

Only Highest Grade of Material Used. Sulphur and Phosphorus guaranteed not to exceed .025%.

Cold Drawing Renders Metal Very Tough, Increases Tensile Strength and Elongation.

Tubes do not Split or Crack when re-rolled in Tube Sheet.

Correspondence solicited. Send us sample order and verify above statements.

SHELBY STEEL TUBE CO.,

General Sales Office, AMERICAN TRUST BLDG., CLEVELAND, OHIO.

MILLS: ELWOOD CITY, PA., GREENVILLE, PA., SHELBY, OHIO, TOLEDO, OHIO.

Eastern Office and Warerooms: **144 Chambers Street, New York, N. Y.**

European Office and Warerooms: **29 Constitution Hill, Birmingham, England.**

Western Office and Warerooms: **135 Lake Street, Chicago, Ills.**

Thornycroft Water-Tube Boiler.

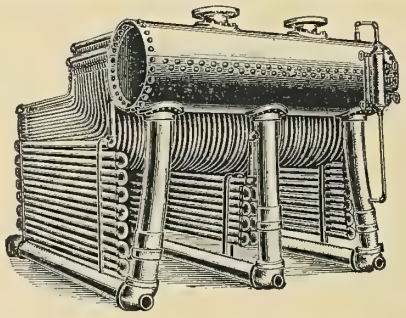
450,000 Horse Power in Use.

THREE OF THESE BOILERS WILL DEVELOP 6,300 I.H.P.

Nine United States Torpedo Boats fitted, also the Pennsylvania Railroad Ferry Boats "New Brunswick" and "Philadelphia." Highest Efficiency, Maximum Power, Minimum Weight and Space. From their light weight and great efficiency they are the best boilers to substitute for the old cylindrical boiler.

THORPE, PLATT & CO.,

9 CEDAR ST., NEW YORK.



Perspective view of the 250 H. P. boiler built for steamboat "Clara," having 6 feet face and 8 feet length; 37 7-12 square feet of grate area and 1900 square feet heating surface. Weight of boiler and water, 14,000 lbs.

We claim for the Boyer Sectional Water Tube Boilers, that they are of an entire new design, are simplest in construction, are accessible to all parts, are rapid steamers with short circulation, have low centre of gravity, have no joints in the fire, have no dead ends, occupy less space in width, length and height than any other, are easily fired, can be repaired or set up by any ordinary mechanic, do not require a brick casing and are shipped whole or knocked down into packages for transportation by man or beast.

BOYER PATENT SECTIONAL WATER TUBE BOILER CO.,

90 Wall Street, New York, N. Y.

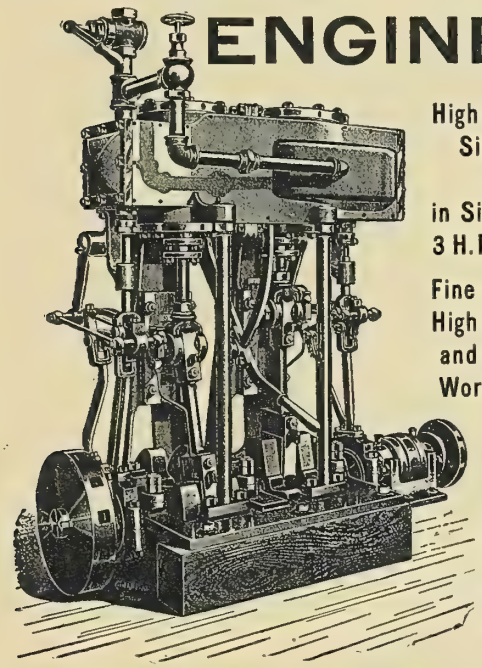
STEAM ENGINES for launches, yachts, tugs and other vessels.

We also make a full line of all kinds of **GAS ENGINES.**

Marine repair work of all kinds promptly attended to.

CRUICKSHANK ENGINE CO., 286 DYER ST., PROVIDENCE, R I.

MARINE ENGINES,



High Speed, Single and Compound, in Sizes from 3 H.P. upwards.

Fine Design, High Finish and First-class Workmanship.

Large Accessible Bearings with Automatic Lubrication, Light but Strong Construction.

Moderate Prices.

Write for Circulars.

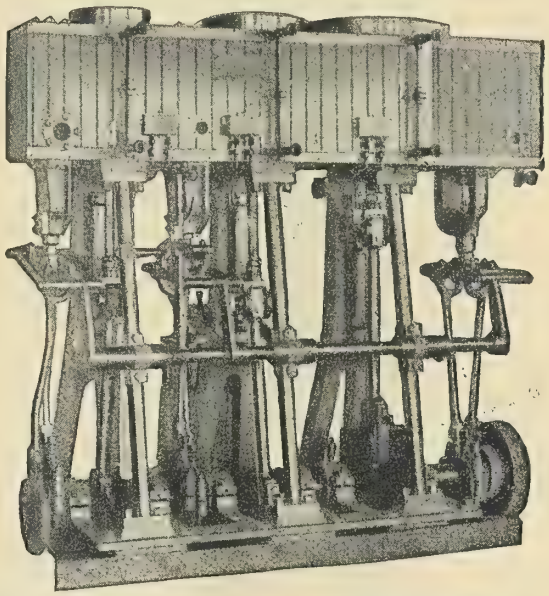
MORRIS MACHINE WORKS,
BALDWINSVILLE, NEW YORK.
New York Office, 39 & 41 Cortlandt Street.

Marine Engines

AND MACHINERY FOR YACHTS, PASSENGER BOATS AND TUGS.

Also makers of the well known

- - - PAINE PROPELLER WHEEL. - - -



Long Distance Telephone. **Your Inquiries Solicited.**

JAMES H. PAINE & SON,
Cor. Clayton and Park Sts., BOSTON, MASS.

We make a full line of simple, compound and triple expansion . . . .

MARINE ENGINES

First-class repair work promptly and thoroughly done.

CHARLES L. KING, foot of 55th Street, BROOKLYN, N. Y.

BY SIMPLY PRESSING A BUTTON YOU CAN

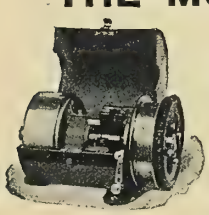
STOP YOUR ENGINE

Close any valve in your steam pipe.
Throw out a friction clutch.
Stop a water wheel.
Stop a gas or oil engine.
Stop anything controlled by valve or lever

If your Engine Starts to Race or RUN AWAY
THE MONARCH SPEED LIMIT Stops It Automatically.

SHOULD YOUR

STEAM PIPE RUPTURE,



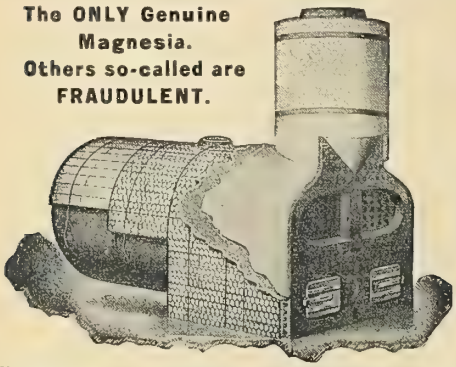
THE MONARCH STOP CLOSES THE BOILER STOP VALVE AUTOMATICALLY.

By placing press buttons in various positions about the ship, your engine or boiler valves can be closed almost instantly by touching any one of them.
Write for Illustrated Catalogue and Particulars.

THE MONARCH MFG. CO., 39 Cortlandt Street, NEW YORK.

MAGNESIA SECTIONAL COVERING

The ONLY Genuine Magnesia. Others so-called are FRAUDULENT.



Over 85% Carb. of Magnesium

USED ON

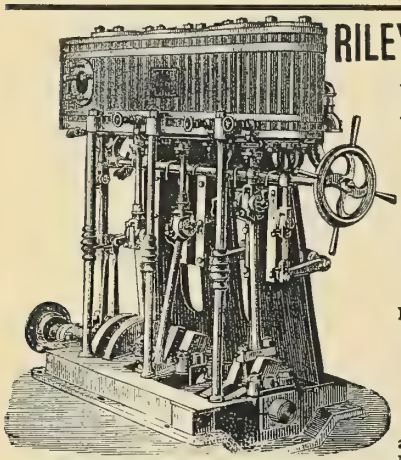
Nine-tenths of the U.S. Government vessels.

More High-Class Yachts than All Other Coverings Combined.

All leading S. S. S. B., Towing and Dredging Lines, etc.

Send for References, Tests, Prices, etc., etc., to

113 TERRACE, BUFFALO. ROBERT A. KEASBEY, 83 WARREN STREET, NEW YORK.



RILEY & COWLEY,

Machinists

—and—

Engineers,

Richards St., Cor. Bowne, South Brooklyn, N. Y.

Builders of Compound and Triple Expansion Engines for Steam Launches, Yachts and Tow Boats.

Repairs in all of the above branches upon reasonable terms.

THE WATSON RADIAL WATER-TUBE BOILER.

Lightest, cheapest and most practical in market; furious steamer; compact, wholly made of steel plate and tubes, no castings or bricks; any desired pressures up to 500 lbs. per square inch; sizes fully tested are 3 1-2 h. p., 10 h. p. and 20 h. p., but any size up to 225 h. p. simple engine (400 compound) will be made. Boilers made to order only; none allowed to be carried in stock for marine work. Performance guaranteed in every case or money returned. Send for illustrated catalogue to

EGBERT POMEROY WATSON,
ELIZABETH, N. J.

NEW YORK'S FINEST PLEASURE TRIP.

The finest pleasure trip out of New York harbor is by the boats which ply between New York and Hartford, Conn.

The screw steamers "Middletown" and "Hartford" are new and commodious, the meals served excellent, the trip inexpensive, and the scenery up the Connecticut River superb.

The New York pier is 24 East River, and the boats leave each end daily at 5 P. M., except Sundays.

MAKING STEAM REVOLUTIONIZED.

The

PARAGON BOILER

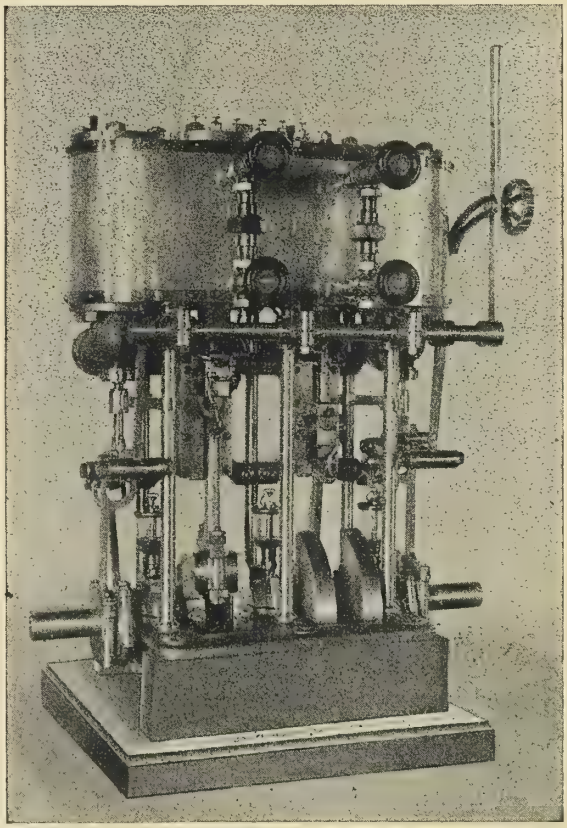
Has Been Practically Tested in Erie Canal Steamers.

FUEL BILLS CUT IN TWO.

The great saving is due to unequaled heating surface and free circulation of water.

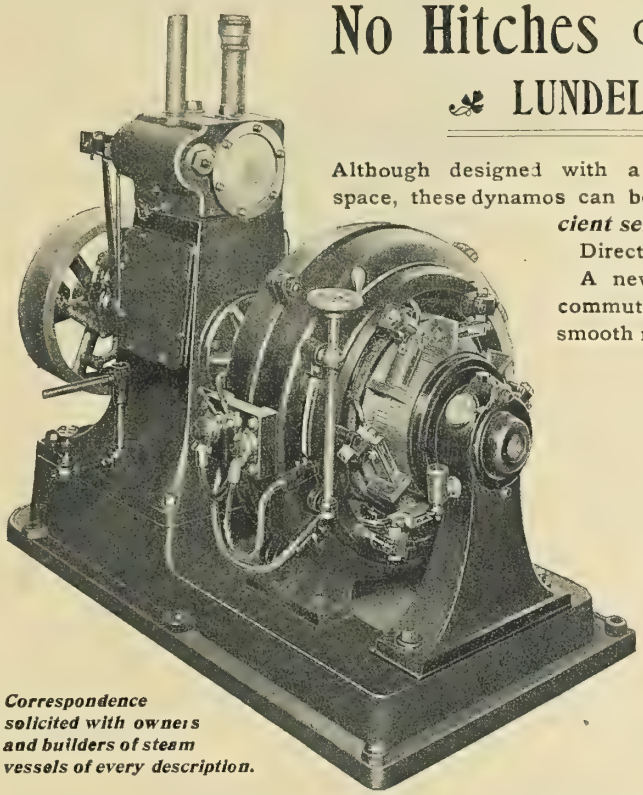
For Particulars Address M. DE PUY, *Patentee,*
19 South Street, NEW YORK.

Yacht, Blower AND Electric Light Engines



In Stock OR In Progress AT All Times Compound and Single.

W. D. FORBES & CO., Hoboken, N. J.



No Hitches OR Breakdowns WITH
LUNDELL GENERATORS.

Although designed with a view to compactness and economy of space, these dynamos can be depended upon for ***continuous and efficient service.***

Direct connected to any make of engine.

A new pattern of brush-holder eliminates all commutator troubles, insuring cool, sparkless and smooth running.

WE ALSO MANUFACTURE DIRECT-CONNECTED VENTILATING AND FORCED-DRAFT OUTFITS.

SPRAGUE ELECTRIC COMPANY,

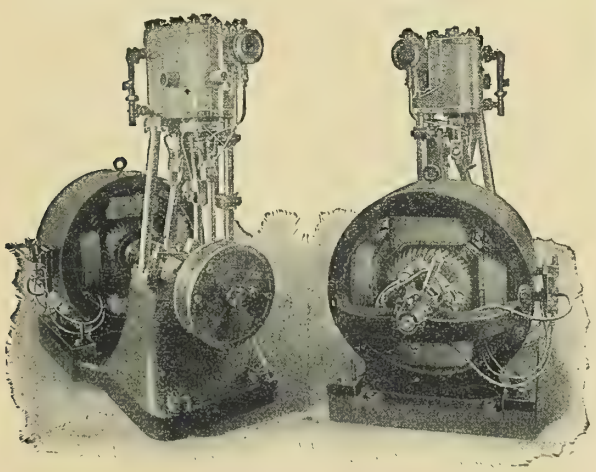
20 BROAD STREET,

NEW YORK.

CHICAGO:
MARQUETTE BLDG.

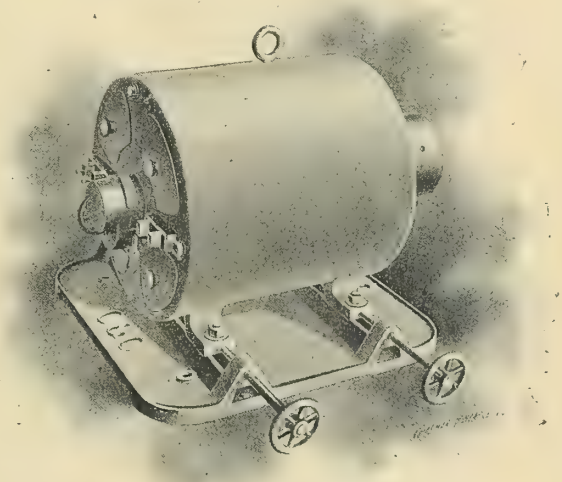
Correspondence solicited with owners and builders of steam vessels of every description.

THE...
BULLOCK
Electric Mfg. Co.



Generator and Engine in W. R. Hearst's Yacht "Buccaneer."

CINCINNATI, O.



DUST AND WATER PROOF

ELECTRIC MOTORS

for driving all class of machinery in shipyards and factories. . . .

MARINE GENERATING SETS, DYNAMOS AND MOTORS

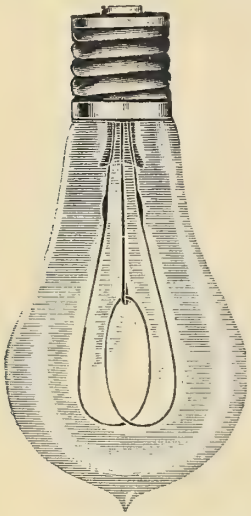
of most modern types for all purposes.

THE C & C ELECTRIC CO.,

MANUFACTURERS,

General Offices, 143 Liberty St., New York.

WE DO IT.



A high grade incandescent lamp will, at 3.5 watts per c.p. efficiency, average a maintenance of its initial candle power for at least 300 hours and have an average life of over 600 hours.

..BEACON..

are the only lamps which can and are guaranteed to do it.

Write us for further particulars. Agents wanted.

Beacon Lamp Co.

New Brunswick, N. J.

NEW HAVEN STEAMBOAT COMPANY.

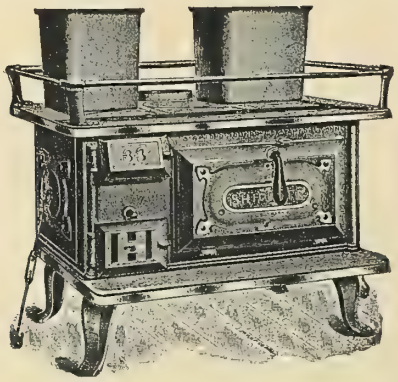
The service of the well-known steamers Richard Peck and C. H. Northam between New York and New Haven is more popular than ever this season. It is a most convenient way to reach New England, as well as a delightful trip. The company's piers in New York are 25 and 26 East River, just below the Brooklyn Bridge.

BOSTON AND BANGOR STEAMSHIPS

For Mt. Desert, Rockland, Bangor and other cities in Maine. It is one of the finest Sea Trips on the coast.

WM. H. HILL, General Manager,
Boston, Mass.

Pier at 368 Atlantic Avenue, Boston.



Some time since we mentioned the large ports in which we have Shipmate agencies.

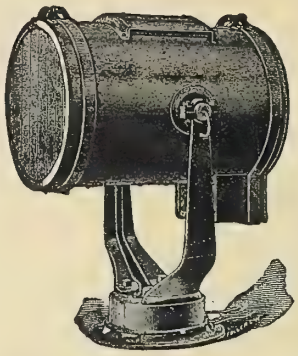
Besides those we have agencies in the following ports:

Milbridge, Me., Ellsworth, Me., Bucksport, Me., Searsport, Me., Belfast, Me., Rockland, Me., Gloucester, Mass., Provincetown, Mass., New Bedford, Mass., Newport, R. I., Noank, Conn., Bridgeport, Conn., South Norwalk, Conn., Port Jefferson, N. Y., Jacksonville, Fla., and Pensacola, Fla.

THE STAMFORD FOUNDRY COMPANY,
STAMFORD, CONN.

Established 1830.

Electric Search Lights



FROM
1,000 to 10,000 Candle Power
ADAPTED TO
Lake & Ocean Vessels,
ALSO TO
Launches and Yachts.

SEND FOR CATALOGUE "A."

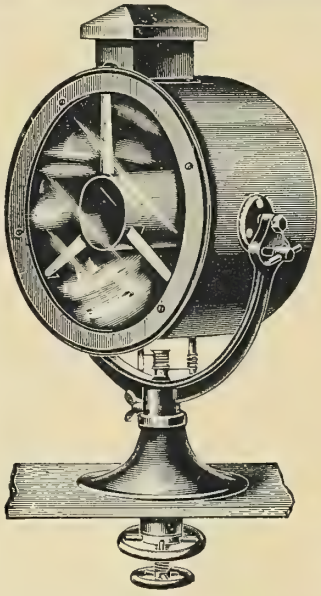
The Carlisle & Finch Co.,
834 W. 6th STREET,
CINCINNATI, OHIO.

YACHTSMAN'S

SEARCH LIGHT

ACETYLENE SEARCH LIGHTS

Suitable for Boats of All Sizes.



Free from Danger,
Easily Handled,
More Economical Than Electricity,
Mechanically Perfect,
Very Powerful.

ACETYLENE GENERATORS

FOR ALL PURPOSES

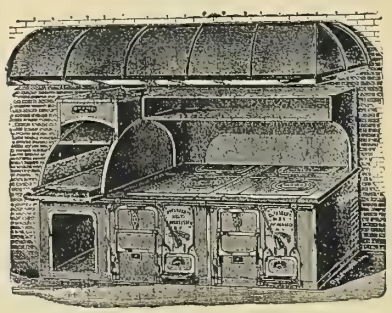
From $15 Up.

Send for Information and mention "Marine Engineering."

J. B. COLT CO. DEPT. B 1, 3 to 7 W. 29th St., New York.

FRENCH COOKING RANGES,

and Cooking Apparatus of every description for Steamships, Yachts, etc.



Established 1852.

Branch Salesrooms,
79, 81, 83
Market Street,
Chicago, Ill.;
6 Union Street,
Boston, Mass.

DUPARQUET, HUOT & MONEUSE CO.

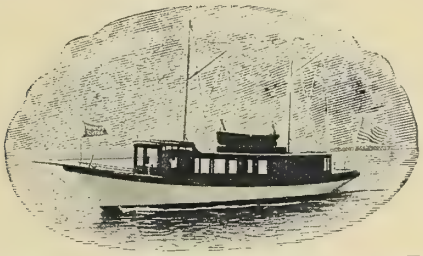
Office and Warerooms: 43 & 45 Wooster St., New York City.

YACHT TENDERS,

ROW BOATS,
DORIES,
CANOES,
FOLDING BOATS.

Strictly first class small boat work of all kinds.
C. B. MATHER & CO.,
Rowley, Mass.

Anything from a 16-Foot Tender to a 100-Foot Yacht.
Fitted with the Simplest, Safest, Speediest and Most Reliable of
MOTORS.



THE DAIMLER.

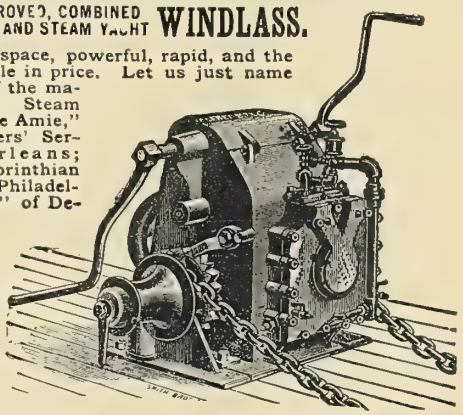
Made in Sizes from 1 to 25 Horse Power.
Everything in the Line of Boats. . . .

DAIMLER MANUFACTURING CO.,
937-945 Steinway Avenue, Steinway, Long Island City, N. Y.

BOX'S IMPROVED, COMBINED HAND AND STEAM YACHT WINDLASS.

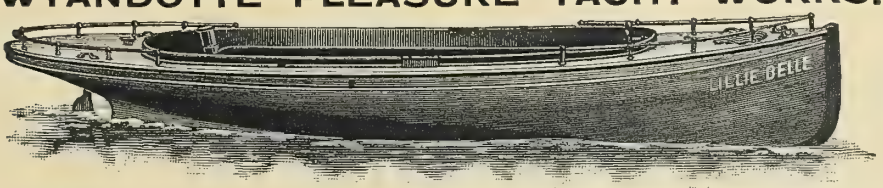
Minimum space, powerful, rapid, and the most reasonable in price. Let us just name one or two of the machines in use. Steam Yachts—"Chere Amie," U. S. Engineers' Service, New Orleans; "Manatee," Corinthian Yacht Club, Philadelphia; "Truant," of Detroit, Mich.

Particulars Cheerfully Furnished.



ALFRED BOX & CO.,
Front, Poplar & Canal Sts.,
PHILADELPHIA, PA

WYANDOTTE PLEASURE YACHT WORKS.



BUILDERS OF
HIGH GRADE BOATS,
STEAM and NAPHTHA
LAUNCHES, SAIL BOATS,
ROW BOATS and CANOES.

Inclose 5 cents in stamps for 1898 catalogue.
Box 505, Wyandotte, Mich.

ALFRED B. SANDS & SON,

YACHT AND MARINE PLUMBERS,

And Manufacturers of

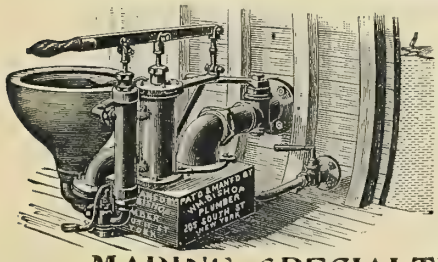
PUMP WATER CLOSETS

For above or below Water Line. Suitable for Naval Vessels, Yachts, Torpedo Boats and Launches,

PUMPS, TANKS, Etc., Etc.

134 BEEKMAN ST., - - NEW YORK.

PATENT PUMP WATER CLOSETS.



BRASS AND COPPER PUMPS, DECK PLATES, SEA COCKS, TANKS, VENTILATORS AND OTHER

MARINE SPECIALTIES.

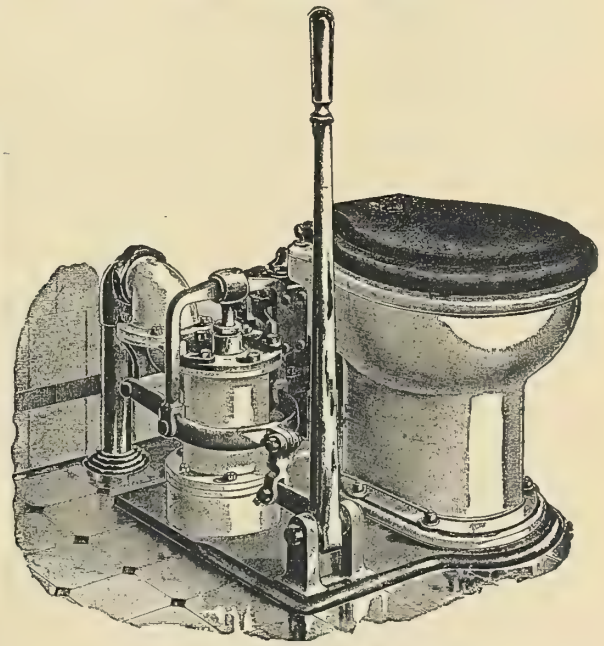
Coppersmiths. Steam Fitters. Marine Plumbing.

WM. BISHOP'S SONS,
205 South St., NEW YORK. 724 Third Ave., BROOKLYN.
New York Telephone Call, 197 Franklin.

HOWELL'S PATENT

MARINE PUMP WATER CLOSET

THE "NEPTUNE"



ONE LEVER DOES THE WORK.

Circulars giving full information furnished upon application.

McCAMBRIDGE & CO., Ltd.,
523, 525 & 527 Cherry Street, PHILA., PA., U. S. A.

M. W. FOGG *Manufacturer of*

Cushions, Draperies and Bedding . . . .

FOR YACHTS, STEAMSHIPS, Etc.

195 Front St., Cor. Fulton St.

NEW YORK CITY

S. HEMMENWAY & SON,

Sail Makers,

ALSO
MANUFACTURERS OF

TENTS, FLAGS AND COVERS.

Send 5 cents for Illustrated Catalogue.

60 South Street, New York City.

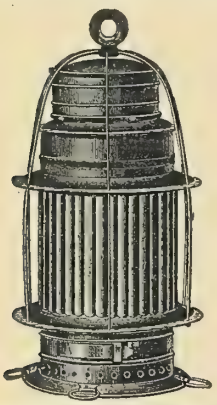
TELEPHONE 527 JOHN.

J. Spencer Turner Co.
109 Duane St., New York.

Cotton Duck
OF ALL WIDTHS.

NOISELESS, FIRELESS, ODORLESS, ATTRACTIVE, INOFFENSIVE, INEXPENSIVE, NON-EXPLOSIVE, DURABLE, REVERSIBLE AND SAFE.
16-18-20 and 25-foot VAPOR LAUNCHES. Price, $150, $165, $225, $375 and $475.
Carvel Build, Copper Fastened, Speed 6 to 9 Miles. Capacity 8 to 20 People. Larger Size to Order. Also all Sizes and Styles of Row and Sail Boats, Canoes, Dinghies, etc. Specialty of **Half so, One Raters.** Send 8c. for Illustrated Catalogue to **Box D.** and **RACINE YACHT & BOAT WORKS, Racine Junction, Wis.**

ADMIRAL DEWEY'S DESPATCH BOAT,



the Revenue Cutter McCulloch,

is fitted with our

10 inch Head and Side Lights and 8 inch Anchor Lights.

RUSSELL & WATSON.

145 Main St., Buffalo, N. Y.

MARINE LAMPS

Oil and Electric.

Signals, Fixtures, Etc.

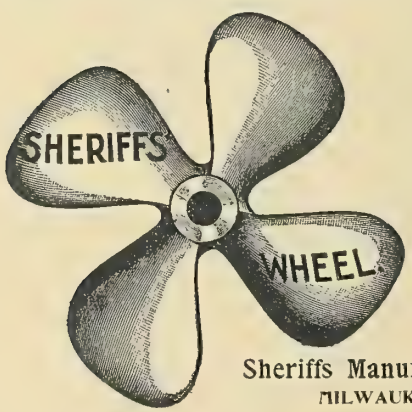
WM. PORTER'S SONS,

271 PEARL STREET, NEW YORK.

MARINE LAMPS **OIL, ELECTRIC AND COMBINATION**
For Government or Private Use

Box Lamps, Ceiling Fixtures, Bunker Lamps, Diving Lamps, Signal Lamps and Side Lights
Steam Tight Globes, Chimneys, Lantern Globes and All Kinds of Glassware
Marine Electrical Material

F. H. LOVELL & CO., 118 John & 231-233 Pearl Sts., New York



Sheriffs Manufacturing Co.,
MILWAUKEE, WIS.

Paul S. Reeves & Son,

PHILADELPHIA, PA.,

Manufacturers of

Propeller Wheels

in all the BRONZES.

Marine Castings a Specialty.

Phosphor-Bronze, Brass, Babbitt Metals.

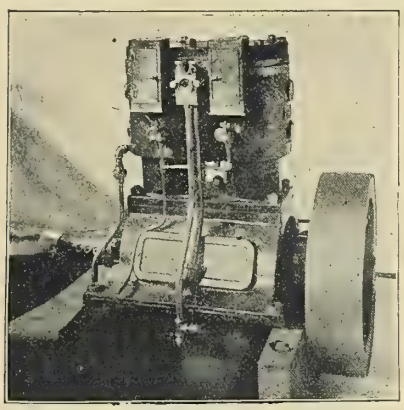
Castings from ¼ to 10,000 lbs. Weight.

ALCO VAPOR

Hunting Launch.

Sportsman's Floating Camp. Motor controlled from bow. Valve movement, 12 to 1. 16 to 60 ft. Launches. Twin Screws a specialty. 1, 2, 3, 5, 7, and 12 h. p. No licensed engineer or pilot required. Speed and Safety guaranteed. **No dangerous Naphtha or Gasoline used.** No disagreeable vibration. SEND TEN CENTS IN STAMPS FOR CATALOGUE.

MARINE VAPOR ENGINE CO., Foot Jersey Ave., Jersey City, N. J.



8 H. P.

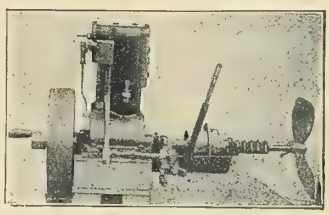
EMPIRE MARINE MOTOR

For Launches, Yachts and Working Boats.

Made by **C. C. RIOTTE CO.,** 1955 PARK AVE., NEW YORK CITY.

COMPACT, SIMPLE, LIGHT.

Sizes 1, 2 and 4 H. P. Single Cylinder; 2, 4, 6, 8, 12 and 20 H. P. Double Cylinder.



1 H. P.

The Only **Seamless Launch**

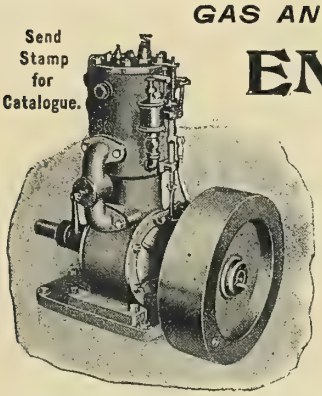
Is built by CRANE BROS., Westfield, Mass.

Builders of Boats, Canoes, Launches, Model Yacht Hulls, and Manufacturers of Linenoid Seamless Specialties. Send for Catalogue.

No Fire, Smoke or Heat. Absolutely Safe. Catalogue Free.
TRUSCOTT BOAT MFG. CO., ST. JOSEPH, MICH.

GAS AND GASOLINE

Send Stamp for Catalogue.



ENGINES.

Both Stationary and Marine

ENGINE CASTINGS....

BOAT FRAME.

A 16-foot Launch, Complete, $178.

MIANUS ELECTRIC CO., BOX M. Mianus, Conn.

JAMES C. WIGNALL,

Boat Builder,

Beach and Vienna Sts., Kensington, Philadelphia, Pa.

Residence: 1025 PALMER STREET.

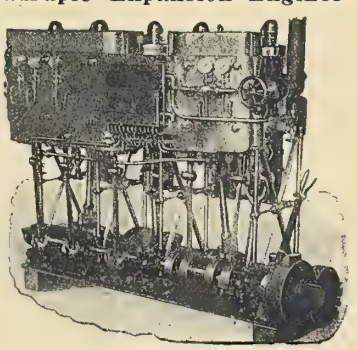
STEAM AND SAILING YACHTS, GUNNING, FISHING AND SPORTING BOATS

OF ALL DESCRIPTIONS BUILT TO ORDER.

THE FASTEST YACHT IN THE WORLD.

Triple and Quadruple Expansion Engines.

GREATEST EFFICIENCY.
MAXIMUM POWER.
MINIMUM WEIGHT AND SPACE.



THE MOSHER PATENT WATER TUBE BOILER.
Over 11,000 horse power of these boilers in the torpedo boats of the U.S. N.

HIGH SPEED STEAM YACHTS A SPECIALTY.
Send for Illustrated Catalogue.
CHARLES D. MOSHER, 1 Broadway, New York.

U. T. HUNGERFORD.

GEORGE DAVIDSON.
BERNARD RIS.
J. R. VAN BRUNT.

TELEPHONE,
259 FRANKLIN.

U. T. HUNGERFORD,

Brass and Copper,

121 Worth St., between Centre and Elm Sts., New York.

SEAMLESS BRASS AND COPPER TUBING

For Condensers, Heaters, Steam Pipes and Coppersmiths' Work generally.

SHEET AND BOLT COPPER.

YELLOW METAL SHEATHING, BOLT AND NAILS.

BRASS AND COPPER

In every Variety of Shape and Form.

We carry a large stock of all above goods on hand for prompt shipment.

Catalogues and Prices Submitted on Application.

SEAMLESS DRAWN

Brass and Copper Tubing

GUARANTEED QUALITY,

FOR

Coppersmiths' Work, Steam Pipes, Condensers, Heaters, &c., &c.

SHEETS, RODS, WIRE, IN COPPER, BRASS, BRONZE.

Yellow Metal Sheathing Bolts and Nails.

MATERIAL FOR SHIP WORK A SPECIALTY.

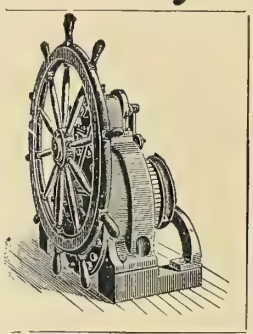
Manufacturers of

BABBITT AND ANTI-FRICTION METALS.

MERCHANT & CO., Incorporated.

PHILADELPHIA, 517 Arch St.
CHICAGO, 36 La Salle St.
NEW YORK, 245-7 Water St.
BROOKLYN, 584 Flushing Ave.

Queen City Patent Hydraulic Steerer.



THE BEST AND MOST RELIABLE.
GENERATES NO HEAT IN PILOT HOUSE.

Has Large Hand Wheel.
Can be Changed from Power to Hand Steering Instantly.
A Favorite with Pilots.

SEND FOR REFERENCES.

QUEEN CITY ENGINEERING CO.,

BUFFALO, N. Y.

BECK'S PATENT STEERING GEAR.

Steam and Hand.
Built in all Sizes.
Simplest, Strongest, Most Reliable.
Changed from Steam to Hand or back by One Lever in less than One Second.

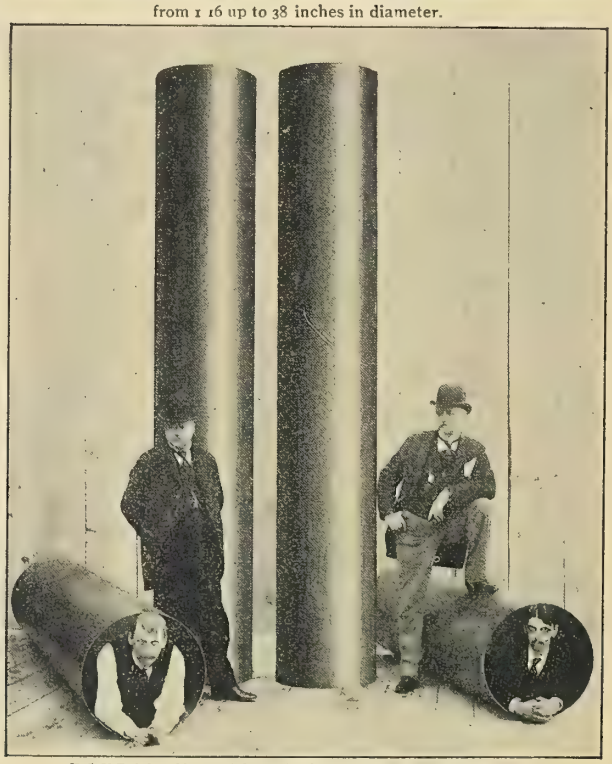
BUILT BY

PAWLING & HARNISCHFEGER,

MILWAUKEE, WIS.

COLD DRAWN SEAMLESS COPPER AND BRASS TUBES

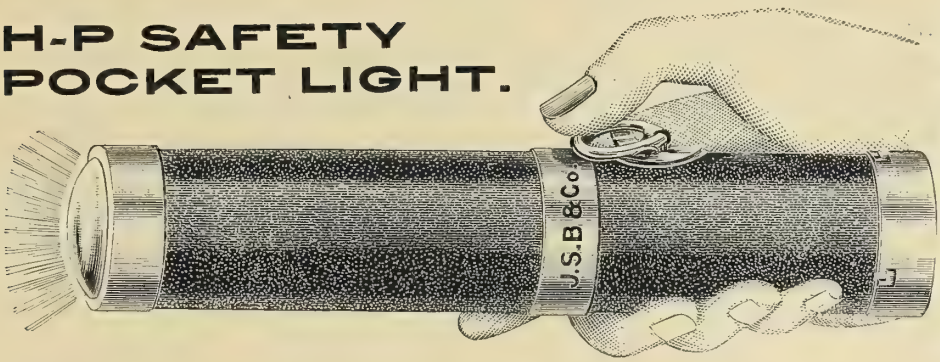
from 1 16 up to 38 inches in diameter.



RANDOLPH & CLOWES, Waterbury, Conn.

BRANCH OFFICES: NEW YORK, Room 202 Postal Telegraph Building, PHILADELPHIA, Room 320 Philadelphia Bank Building. CINCINNATI, Room 308 Neave Building. CHICAGO, 226 Lake Street. BOSTON, Oliver Street Corner of Purchase Street.

H-P SAFETY POCKET LIGHT.



An ever-ready Electric Light for Electricians, Engineers, **Navigators, Ship Officers,** Machinists, Miners, Hunters, Physicians, Watchmen and Policemen, and for all purposes where a safe and handy flash light is desired.

Gives approximately from 6,000 to 8,000 lights before battery requires renewal. Extra batteries 30 cents each. No wires to get out of order. No chemicals to spill. Can be carried into a cellar full of leaking gas, into an oil tank, alcohol and malt vats, or placed in a keg of powder without the slightest danger of explosion. Cut approximately half size. Weight about one and one-eighth lbs. Price, complete, $3.00. By mail, $3.30. JAMES S. BARRON & CO., Manufacturers of and Wholesale Dealers in General Electrical Supplies, 24-30 Hudson St., New York.

BALDT'S PATENT STOCKLESS ANCHOR.

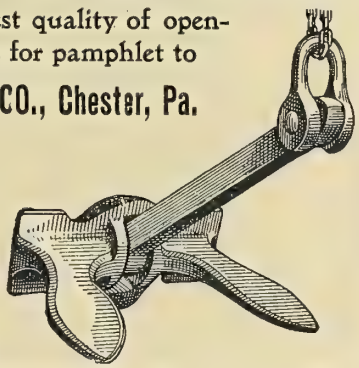
Made of the finest quality of open-hearth steel. Send for pamphlet to

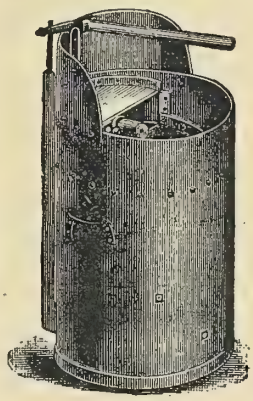
BALDT ANCHOR CO., Chester, Pa.

OR

THOS. PRICE,
136 Liberty St., N. Y.

WALTER MILLER,
Western Reserve Bldg.,
Cleveland, Ohio.





THE CRUMLISH PORTABLE FORGE

FOR RIVET HEATING.

The strongest, lightest and handiest forge on the market. Constructed of steel, circular in form; weighs only 90 pounds; 19 inches in diameter. Used by the leading steamship companies and shipyards of the United States.

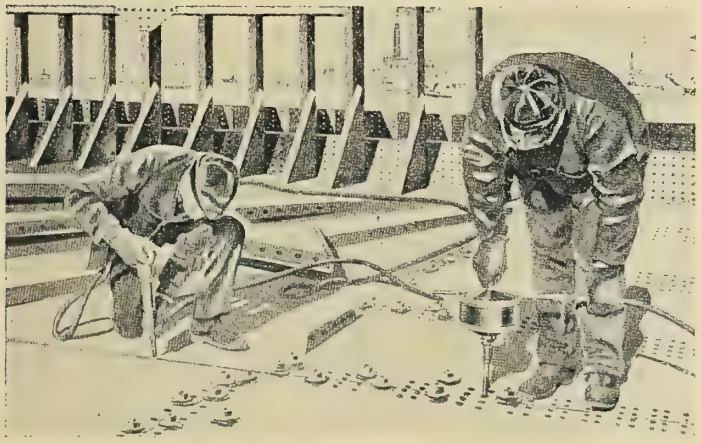
SEND FOR CIRCULAR.

The Crumlish Forge Co.,
BUFFALO, N. Y., U. S. A.

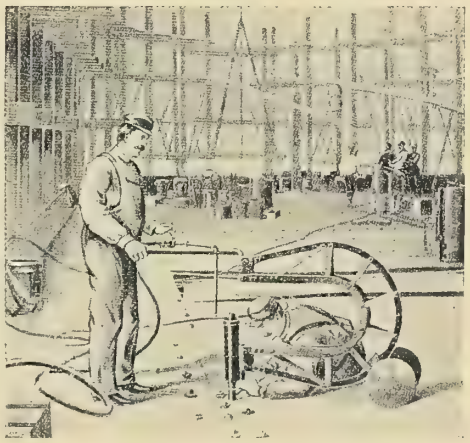
BOYER PNEUMATIC TOOLS

FOR RIVETING, DRILLING, CAULKING,

AND OTHER USES IN CONNECTION WITH SHIPBUILDING.



BOYER PNEUMATIC HAMMER AT WORK CAULKING, AND THE PISTON AIR DRILL REAMING.



BOYER DECK RIVETER AND PNEUMATIC HAMMER ON FLUSH DECK RIVETING.

TOOLS SENT ON TRIAL, SUBJECT TO APPROVAL, AND MAY BE RETURNED AT OUR EXPENSE IF NOT SATISFACTORY.

CHICAGO PNEUMATIC TOOL CO.,

122 LIBERTY STREET, NEW YORK.

Send for our Special Edition Catalogue.

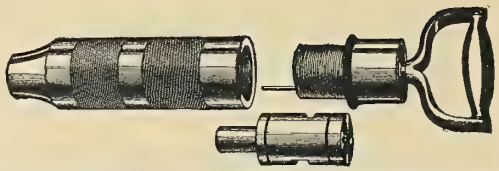
635 MONADNOCK BLOCK, CHICAGO.

MORSE
TWIST DRILL AND MACHINE CO.
NEW BEDFORD, MASS., U. S. A.,

Manufacturers of

Drills, Chucks, Reamers, Milling Cutters, Taps and Dies, and Machinists' Tools.

Send for our 1898 Catalogue.



It has only three parts. Cannot get out of order. We Guarantee it for two years.

THE CLEMENT PNEUMATIC TOOL COMPANY,
123-125 South Eleventh St, PHILADELPHIA, PA.

PNEUMATIC TOOLS

and appliances for Chipping and Caulking Boilers and Ships.

REFERENCE:—Wm. Cramp & Sons, Ship and Engine Building Co., Philadelphia, Pa.

Catalogue on Application.

FORGINGS.

Heavy or Light, Steel or Iron,
Marine, Stationery, or Special,
Rough or Finished Complete.

The Whitestone Forge & Construction Co.,
Offices, 11 Broadway, New York.

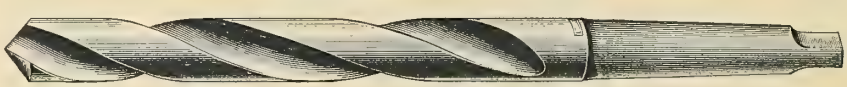
FRANKFORD STEEL COMPANY, ELLWOOD CITY, LAWRENCE CO., PA.

STEEL FORGINGS, HEAVY SHAFTINGS.

In the Rough, Rough Turned or Finished. Office, Fidelity Mutual Building, PHILADELPHIA.

NEW PROCESS TWIST DRILL CO., TAUNTON, MASS.

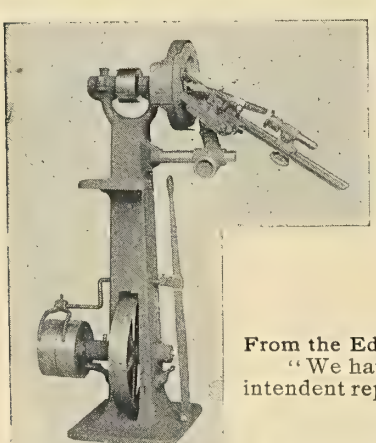
OUR IMPROVED



Hot Forged Twist Drills

ARE ACCURATE, DURABLE AND HIGHLY FINISHED.

We guarantee all goods to be as represented. Kindly write us for Catalogue and Discount Sheet.



"Can't Grind Wrong."

THE YANKEE DRILL GRINDER,

For Grinding Both Twist and Flat Drills,

IS A MACHINE SHOP NECESSITY.

This machine grinds all sized drills from 1/8 to 2 1/4 inches. Can be set for any size in a few seconds. Gives any desired clearance. Also grinds 3 lipped drills and chucking reamers.

We know we have the best and latest machine of the kind made.

WE GUARANTEE IT FULLY.

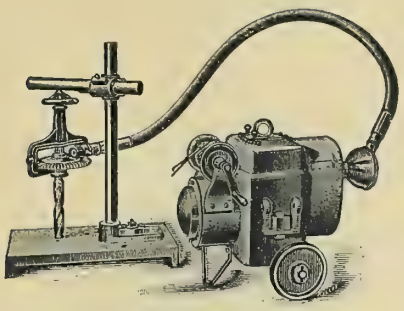
They Have Four Grinders in Use.

From the Edward P. Allis Co. Milwaukee, Wis., Aug. 17, 1894.

"We have four Yankee Twist Drill Grinders in operation, and our Assistant Superintendent reports them as being 'good.'"

SEND FOR PARTICULARS AND TESTIMONIALS OF USERS.

G. T. EAMES CO., 200 Michigan Avenue, Kalamazoo, Mich.



General European Agents,
SELIG SONNENTHAL & CO.,
85 Queen Victoria Street,
London, Eng.

Stow Mfg. Co., Binghamton, N. Y.

Established 1875.

INVENTORS AND LARGEST MFRS. IN THE WORLD OF THE

STOW FLEXIBLE SHAFT

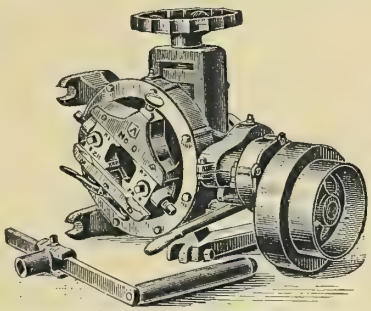
FOR ALL PURPOSES.

Our Combination of FLEXIBLE SHAFT and IRONCLAD ELECTRIC MOTOR is almost indispensable on any vessel having an Electric Current, for portable DRILLING, TAPPING, REAMING, etc. It can be easily transported to any part of the same, and repairs made in a fraction of the time required by hand.

Correspondence solicited.

WRITE FOR CATALOGUE AND PRICE LIST.

ARMSTRONG'S TOOLS FOR MARINE WORK ARE BEST.



No. O Threading Machine, with Power Attachment.

Improved Pipe Threading and Cutting Off Machines, Sizes, ⅛ to 6 inches. Hand or Power.

ARMSTRONG'S Celebrated Adjustable STOCKS and DIES. Universally acknowledged to be the best on the market.

Pipe Wrenches, Pipe Cutters, Clamp Dogs, and other Tools for Water, Gas and Steam Fitters' Use.

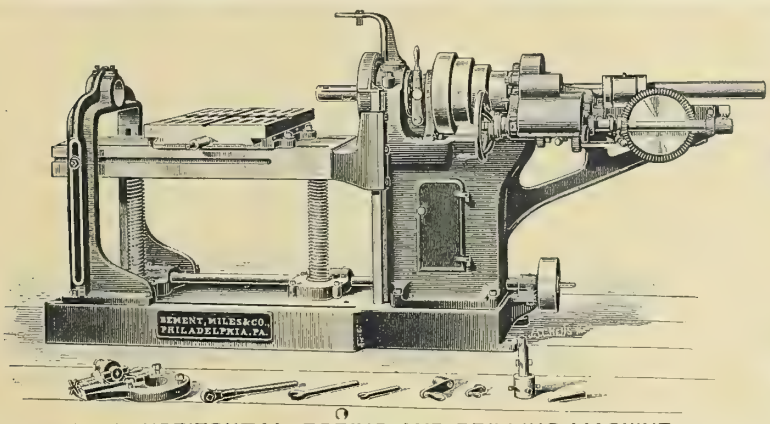
GOT A CATALOGUE?

New No. 3 Pipe Cutter.

THE ARMSTRONG MFG. CO.,

N. Y. Office: 139 Centre Street.

BRIDGEPORT, CONN.



No. 1 HORIZONTAL BORING AND DRILLING MACHINE.

BEMENT, MILES & CO.,

PHILADELPHIA, PA.,

Manufacturers of

METAL WORKING MACHINE TOOLS

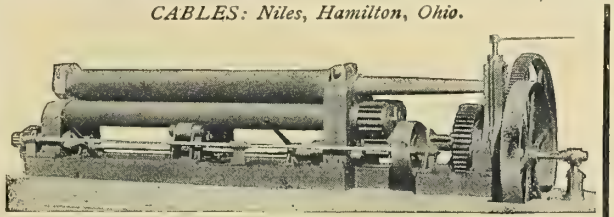
For Shipyards, Boiler Shops, and all kinds of

METAL WORKING ESTABLISHMENTS.

NEW YORK OFFICE: Taylor Bldg., 39 Cortlandt Street

Chicago Office, 1534 Marquette Bldg.

CABLES: Niles, Hamilton, Ohio.



No. 5 BENDING-ROLLS

For Plates 3/4 in. x 12 ft., Cold.

ROLLS For All Sizes Ship and Boiler Plate.

THE....

NILES TOOL WORKS COMPANY,

HAMILTON, OHIO.

Complete Equipments For SHIP YARDS, BOILER YARDS, AND MACHINE SHOPS.

MACHINE-TOOLS.

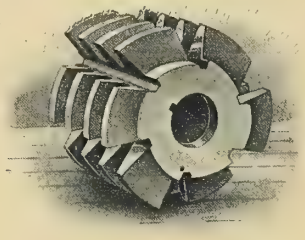
Branches:

NEW YORK, BOSTON, PHILADELPHIA, CHICAGO, PITTSBURGH, ST. LOUIS.

LONDON, S. W., 39 Victoria Street.

(*Telegrams, "Niliacus, London."*)

Hardening



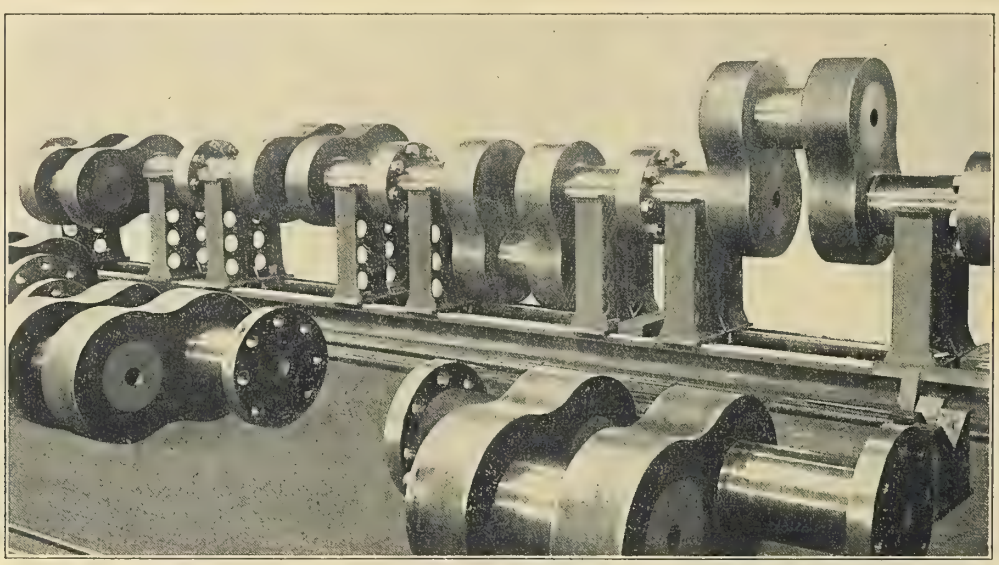
CUSTOM WORK

. . BY . .

Coes' "Pyro-Calcic" Process.

WRITE **L. COES & CO.,**

Box 12, Station B, **WORCESTER, MASS.**



The Auxiliary Cruisers ST. LOUIS and ST. PAUL have Crank Shafts forged under an hydraulic press. The above picture shows one of the Crank Shafts. Diameter of Shaft, 21 inches; diameter of pins, 22 inches.

THESE FORGINGS WERE MADE BY

THE BETHLEHEM IRON COMPANY,

SOUTH BETHLEHEM, PA.

No. 100 Broadway, New York.
No 421 Chestnut Street, Philadelphia, Pa.
No. 1433 Marquette Bldg., Chicago, Ill.

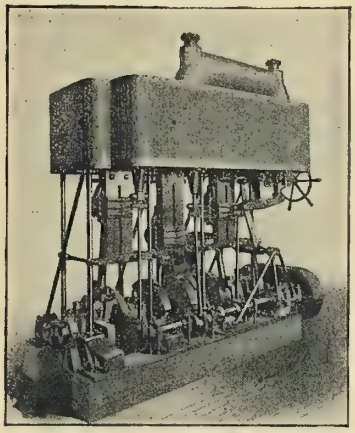
The Charles Hillman Ship and Engine Building Co.

Beach above Palmer St., Philadelphia, Pa.

THE CHICAGO SHIP BUILDING COMPANY,
SHIP BUILDERS and ENGINEERS,
CHICAGO.

THE CLEVELAND SHIP BUILDING CO.
...Steel Ships...
Marine Engines and Boilers.

T. S. MARVEL & CO., NEWBURG, N. Y.
SHIP AND ENGINE BUILDERS.



MARINE ENGINES

Quadruple and Triple Expansion, Compound and Simple. 15 to 3,000 Horse Power.

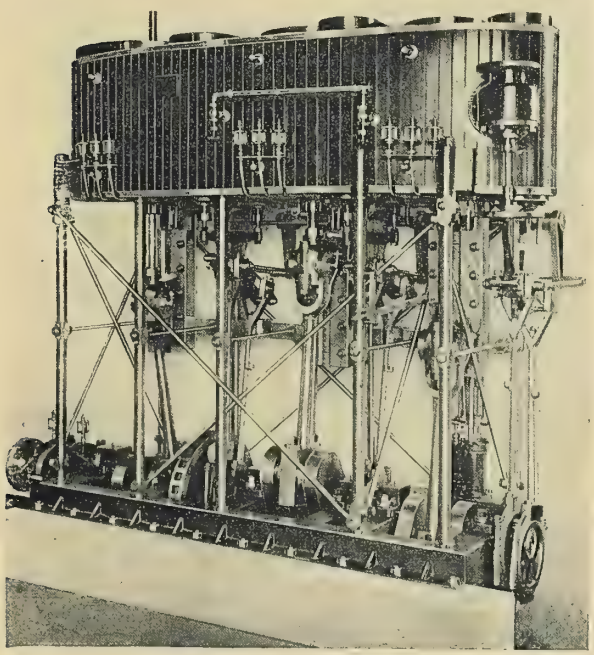
"Seabury's" Water Tube Boilers.
Steam and Sail Yachts.

The Only Naphtha Launch.

Send 10c. stamp for Catalogue.

GAS ENGINE & POWER CO.,
AND
CHARLES L. SEABURY & CO.,
CONSOLIDATED,
Morris Heights, New York City.

Steel and Wooden Steam Vessels.
ENGINES For yachts, torpedo boats and light displacement vessels, also for blower and direct-connected electric plants.
WATER TUBE BOILERS (Bent Tube Type).

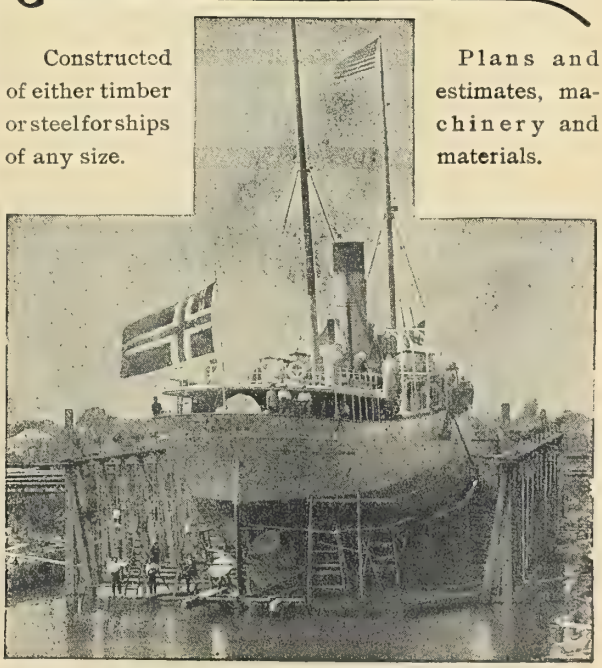


A fully equipped steel vessel plant. Established 1884.
F. O. WELLINGTON, Manager,
FORE RIVER ENGINE CO., WEYMOUTH, MASS.

..BETTER THAN DRY DOCKS..
CRANDALL'S MARINE RAILWAYS.

Constructed of either timber or steel for ships of any size.

Plans and estimates, machinery and materials.



H. I. CRANDALL & SON, ENGINEERS,
100 Border Street, East Boston, Mass., U. S. A.

CABINET HARDWARE

AND TOOLS

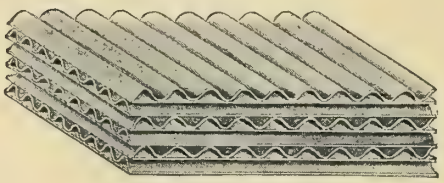
HAMMACHER, SCHLEMMER & CO.

209 BOWERY NEW YORK

ASBESTOS AIR CELL FIRE BOARD!

(Reg. Trade Mark.)

For Lining of **Bulkheads.**



For Covering **Steam Boilers.**

Patented.

New York Asbestos Mfg. Co.,

287-291 DOUGLASS STREET, - BROOKLYN, N.Y.

NEWPORT NEWS SHIPBUILDING & DRY DOCK CO.

WORKS AT NEWPORT NEWS, VA.

(ON HAMPTON ROADS.)

Equipped with a Simpson's Basin Dry Dock capable of docking a vessel 600 feet long, drawing 25 feet of water, at any stage of the tide. Repairs made promptly and at reasonable rates.

SHIP AND ENGINE BUILDERS.

For estimates and further particulars, address

C. B. ORCUTT, Pres't, No. 1 Broadway, New York.

Roach's Shipyard.

The Delaware River. Iron Shipbuilding and Engine Works, . . .

Chester, Pa.

Builders of Steamships and Marine Machinery. Facilities for Work of Every Description.

General Office and Works, - - CHESTER, PA.

New York Office:

MORGAN IRON WORKS, Foot East Ninth Street.

Established 1863. Incorporated 1867.

The Harlan & Hollingsworth Co.,

Wilmington, Delaware, U. S. A.,

SHIP BUILDERS.

Iron and Steel Vessels of all Kinds.
Engines, Boilers and Machinery Generally.
Torpedo Boat Destroyers.

STEAM AND SAILING

YACHTS

OF THE HIGHEST CLASS.

A SIMPSON PATENT BASIN

DRY DOCK

OF 340 FEET LENGTH AND 14 FEET OF WATER.

Special Designs and Specifications.

TEBO'S

YACHT BASIN, COALING STATION AND FLOATING DRY DOCKS,

Foot 23d Street, BROOKLYN, N. Y.

BROOKLYN

FLOATING DOCK AND SHIPYARD.

THEO. A. CRANE'S SONS, PROPRIETORS,

Erie Basin, South Brooklyn.

CAPACITY OF DOCK, 1200 TONS. LENGTH OF KEEL BLOCKS, 200 FEET.

TELEPHONE, 236 HAMILTON.

Established 1838. *Incorporated 1891.*

THE NEAFIE & LEVY

Ship and Engine Building Co.,

Penn Works, Philadelphia, Pa., U. S. A.

BUILDERS OF

Iron and Steel Ships and Engines

OF EVERY DESCRIPTION.

Steamship Repairs A Specialty.

Office: 1336 Beach St, Philadelphia, Pa.

The Atlantic Works,

BORDER, MAVERICK and NEW STS., EAST BOSTON, MASS.

(Docks opposite Navy Yard.)

Builders of

STEAMSHIPS, TOW BOATS AND STEAM YACHTS

IN STEEL AND WOOD.

Marine Engines, Boilers, etc. Hull, Boiler and Engine Repairs.

LEWIS NIXON, Shipbuilder.

Office and Works: Elizabethport, N. J.

BUILDER OF STERN WHEEL, PADDLE AND SCREW

Steamers, also Torpedo Boats and Barges

OF ALL KINDS IN STEEL.

A SPECIALTY MADE OF

South American and Alaskan River Boats.

Cramp's Ship Yard,

PHILADELPHIA, PA.

Battle Ships, Cruisers, Passenger and Freight Steamships, etc.

STEAM MACHINERY of every description, including boilers and all equipment; Marine Engines of any desired power, Gun Carriages, Basin Dry Dock and Marine Railway, Parsons' Manganese Bronze and White Brass, Water Tube Boilers (Niclausse, Mosher, Yarrow).

AREA OF PLANT, thirty-two acres. Area covered by buildings, fifteen acres. Delaware river front, 1,543 feet.

FLOATING DERRICK "ATLAS." Capacity 130 tons, with 60 feet hoist and 36 feet out-hang of boom.

NUMBER OF MEN EMPLOYED, about 6,000 in all departments.

GREAT LAKES REGISTER.

COMBINED AND ISSUED IN CONNECTION WITH

BUREAU VERITAS.

INTERNATIONAL REGISTER OF SHIPPING.

F. D. HERRIMAN, Surveyor General.

Main Office, Royal Insurance Building, Chicago, Ill.

Now prepared to issue Certificates upon Wood and Metal Vessels, Supervising Construction, Etc.

GREAT LAKES REGISTER desires to announce that its ratings go before the leading underwriters of America, England and France.

The services of its surveyors, who are located at all principal ports, may be engaged on Hulls and Cargoes.

EXPERIENCE 40 YEARS

MANUFACTURING

HAND POWER PUMPS—FREE AND FORCE. Yachts, Schooners, Ships, Barges, Scows (Deck and Bilge), Contractors' Trenches, Vaults, Cesspools, Manholes, Brick Yards, Mines, Irrigating, Tanneries, Weir Pole Driving, or for any duty where **Hand Power** is used.

WINCHES. Cargo, Chandelier, Derrick, Portable and Centerboard.

WINDLASSES. Gypsy and Pump Brake.

STEERING GEARS. Cape Catboats, Knockabouts, Sloops, Schooners, Ships, Launches and Steamboats.

RELIEF STEERING GEARS. Steam Yachts, Steamships.

CAPSTANS. Common and Power.

FANCY WOOD STEERING WHEELS. 19 inch to 72 inch.

BRASS WORK. Stanchions, Deck Plates and Gratings, Hood Ventilators.

MECHANICAL FOG HORNS. King (Lever), Edson (Crank).

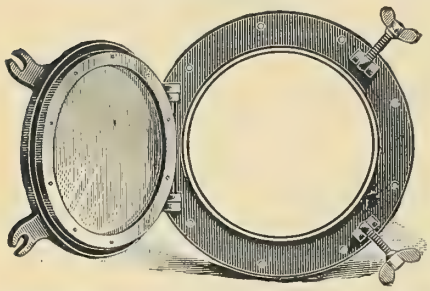
Street Sweeping Machines. Automatic Bottle Fillers.

Send for Illustrated Catalogue.

EDSON MANUFACTURING CO.,

132 Commercial St., BOSTON, MASS.

VESSEL MACHINERY AND SUPPLIES.



Windlasses, Captans, Pumps, Steering Apparatus.

Marine Monitor Side Lights.

Contractors' Supplies.

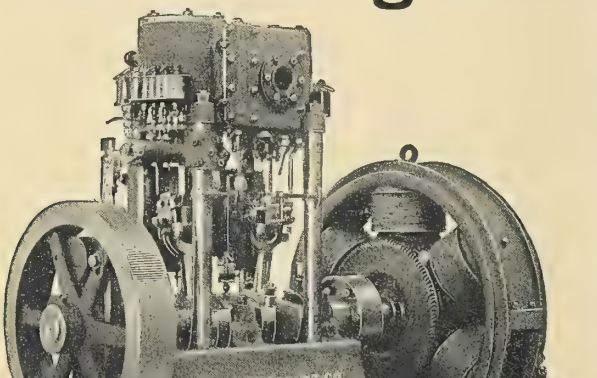
Shipbuilders' Supplies.

Oakum, Caulking Cotton, Deck Plugs, Pitch, Tar.

General Line of Ship Chandlery, Marine Hardware, Cordage, Wire. Rope, Yacht Supplies, Flags, Signals, etc.

Marine Manufacturing & Supply Co., 158 South St., New York.

STURTEVANT Generating Sets



SIZES UP TO 65 K. W.

Send for Catalogue.

B. F. STURTEVANT CO.

Works: Boston, Mass., U. S. A.

BOSTON. NEW YORK. CHICAGO. PHILADELPHIA. LONDON. GLASGOW. BERLIN. STOCKHOLM.

INDEX TO ADVERTISERS.

ANCHORS.
Baldt Anchor Co. ... 67

ANCHOR CABLES.
Carr, J. B., Co., The ... inside front cover

AUXILIARY STEAM APPLIANCES AND FITTINGS.
American Steam Gauge Co. ... 55
Ashton Valve Co. ... inside front cover
Bloomsburg, H., & Co. ... 54
Cobb, D. McLeod ... 53
Coldwell-Wilcox Co. ... 47
Craig, Wm. ... 55
Dart, E. M., Manufacturing Co. ... 54
Deane Steam Pump Co. ... inside front cover
Eynon-Evans Mfg. Co. ... 55
Haines, W. S., Co. ... 43
Learmouth, Robert. ... 56
Mason Regulator Co. ... 46
Phillips, W. P., & Co. ... 56
Penberthy Injector Co. ... 50
Robertson, Jas. L., & Son ... 47
Ross Valve Co. ... 56
Snider-Hughes Co., The ... 53
Snow Steam Pump Works ... 56
Stephens, Roe, Mfg. Co. ... 53
Taunton Locomotive Mfg. Co. ... 53
Worthington, Henry R. ... 56

BEARINGS.
Ball Bearing Co., The ... outside back cover
Graphite Lubricating Co. ... 54

BOILERS.
Almy Water Tube Boiler Co. ... 57
Boyer Patent Sectional Water Tube Boiler Co. ... 58
Clark, Edw. S. ... 57
De Puy, Captain M. ... 60
Kingsford Foundry & Machine Works ... 57
Rochester Machine Tool Works ... 57
Thorpe, Platt & Co. ... 58
Tonkin, J. J. ... 57
Watson, E. P. ... 60

BOILER COMPOUND.
Warley, Thomas C., & Co. ... 52

BOILER TUBES.
Shelby Steel Tube Co. ... 58

BRASS AND COPPER.
Hungerford, U. T. ... 66
Merchant & Co. ... 66
Randolph & Clowes ... 66

CAPSTANS AND WINDLASSES.
Box, Alfred, & Co. ... 63
Hyde Windlass Co. ... outside back cover

COTTON DUCK.
J. Spencer Turner Co. ... 64

DRAUGHTSMEN'S SUPPLIES.
Alteneder, Theo., & Sons ... 68

DREDGING.
Morris & Cumings Dredging Co. ... outside back cover
New York Dredging Co. ... outside back cover

EDUCATIONAL.
American School of Correspondence ... 44
Electrical Engineer Inst. of Correspondence ... 47
International Correspondence Schools ... 54

ELECTRICAL APPARATUS AND SUPPLIES.
Barron, James S., & Co. ... 67
Beacon Lamp Co. ... 62
Bullock Electric Mfg. Co. ... 61
C & C Electric Co. ... 61
Sprague Electric Co. ... 61
Sturtevant, B. F., Co. ... 74
Weston Electrical Instrument Co. ... 45

ENGINES—GASOLINE.
Mianus Electric Co. ... 65
Riotte, C. C., Co. ... 65

ENGINES—STEAM.
Cruickshank Engine Co. ... 59
Forbes, W. D., & Co. ... 60
Halsey, James T. ... 55
King, Charles L. ... 59
Morris Machine Works ... 59
Paine, James H., & Son ... 59
Riley & Cowley ... 60

FORGES.
Crumlish Forge Co. ... 67

FORGINGS AND CASTINGS.
Bethlehem Iron Co. ... 70
Frankford Steel Co. ... 68
Whitestone Forge & Construction Co. ... 68

FREIGHT CONVEYORS.
Link Belt Engineering Co. ... 75

LAMPS, SIGNALS AND FIXTURES.
Lovell, F. H., & Co. 64
Porter's Sons, Wm. 64
Russell & Watson. 64

LUBRICATION.
Dixon, Joseph, Crucible Co. 44

MARINE GLASSES.
Bausch & Lomb Optical Co. 76

MARINE RAILWAYS.
Crane's Sons, Theodore A. 73
Tebo's Dry Dock Co. 73

MARINE RAILWAY BUILDERS.
Crandall, H. I., & Son. 71

MARINE STORES AND SUPPLIES.
Edson Mfg. Co. 74
Marine Manufacturing & Supply Co. 74

METAL POLISH.
Bertram's Oil Polish Co. outside back cover
Rath Mfg. Co. 54

MISCELLANEOUS.
Great Lakes Register. 73
Wells Light Mfg. Co. 76

NON-CONDUCTING COVERINGS.
Keasbey, Robert A. 60
New York Asbestos Mfg. Co. 72

OIL FILTERS.
Burt Manufacturing Co. 55

PACKING.
Boston Belting Co. 52
Brandt, Randolph. 52
Chesterton, A. W., & Co. inside back cover
Daniel, C. A. 51
Garlock Packing Co. 51
Katzenstein, L., & Co. 52
Knowlton Packing Co. 52
Peerless Rubber Mfg. Co. 48
Regal Packing Co. 51
St. John Cylinder Packing Co. 54
U. S. Metallic Packing Co. 52

PAINTS AND PRESERVATIVES.
American Pegamoid Co. 75
New Jersey Zinc Co. 46

PNEUMATIC TOOLS.
Chicago Pneumatic Tool Co. 67
Clement Pneumatic Tool Co. 68

PROFESSIONAL CARDS.
H. B. Roelker. 47

PROPELLER WHEELS.
Reeves, Paul S., & Son. 64
Sheriffs Mfg. Co. 64

RANGES—SHIP AND GALLEY.
Duparquet, Huot & Moneuse Co. 62
Stamford Foundry Co. 62

REFRIGERATING MACHINES.
Kilbourn Construction Co. 76

ROPE AND CORDAGE.
American Manufacturing Co. inside front cover

SAIL MAKERS.
Fogg, M. W. 64
Hemmenway, S., & Son. 64

SEARCH LIGHTS.
Carlisle & Finch Co. 62
Colt, J. B., Co. 62

SHIP BUILDERS.
Atlantic Works. 73
Chicago Ship Building Co. 71
Cleveland Ship Building Co. 71
Cramp, Wm. & Sons, Ship and Engine Building Co. 73
Delaware River Iron Ship Building & Engine Co. 72
Detroit Dry Dock Co. 49
Fore River Engine Co. 71
Gas Engine & Power Co., C. L. Seabury & Co., Con. 71
Harlan & Hollingsworth Co. 72
Hillman, Chas., Ship and Engine Building Co. 71
Marvel, T. S., & Co. 71
Neafie & Levy Ship & Engine Building Co. 73
Newport News Ship Building and Dry Dock Co. 72
Nixon, Lewis. 73

SPEED-CONTROLLING APPARATUS.
Monarch Mfg. Co. 59

STEERING APPARATUS.
Pawling & Harnischfeger. 66
Queen City Engineering Co. 66

TOWING AND TRANSPORTATION.
Luckenbach, Lewis. 76

TOOLS—BENCH.
Coes, Loring, & Co. 70
Hammacher, Schlemmer & Co. 72
Morse Twist Drill & Machine Co. 68
New Process Twist Drill Co. 68
Stow Mfg. Co. 69
Williams, J. H., & Co. outside back cover

TOOLS—MACHINE.
Armstrong Mfg. Co. 69
Bement, Miles & Co. 69
Eames Co., The G. T. 68
Niles Tool Works Co. 69

WATER CLOSETS.
Bishop's, Wm., Sons. 63
McCambridge & Co., L't'd. 63
Sands, Alfred B., & Son. 63

WORM GEARING.
Albro-Clem Elevator Co. 44
Morse, Williams & Co. 44

YACHT AND BOAT BUILDERS.
Crane Brothers. 65
Daimler Manufacturing Works. 63
Marine Vapor Engine Co. 65
Mather, C. B., & Co. 63
Mosher, Chas. D. 65
Racine Yacht & Boat Works. 64
Truscott Boat Mfg. Co. 65
Wignall, Jas. C. 65
Wyandotte Pleasure Yacht Works. 63

"PEGAMOID" TRADE MARK
ALUMINUM PAINT.
Latest Application of Aluminum. Looks like Frosted Silver. Washable, Untarnishable, Water, Oil and Weather Proof. Durable. Easily Applied. Yachts, Bicycles, Radiators, Pipes, Metal Work, Machinery, etc. Makes tarnished objects better than new. A necessity to the Yachtsman, Marine Engineer and Boat Builder. Sample Bottle and Circular for 25 cents.
AMERICAN PEGAMOID CO., 346 Broadway, N. Y.

FREIGHT RAMP.
Carries freight to or from vessels.
Readily adjusted to meet varying heights of ports.
Reduces labor force, also time to load and unload.
Increases capacity of pier.
"Cost of Ramps saved in seven months," writes one user.

ELEVATORS. CONVEYORS.
COAL HANDLING MACHINERY.

LINK-BELT ENGINEERING CO., NICETOWN, PHILA. 49 DEY ST., N. Y.

Coast Towing, Transportation and Wrecking.

We have every facility for doing wrecking work promptly and scientifically.

Our fleet comprises the finest ocean-going tugs and the largest and stanchest barges on the coast.

LEWIS LUCKENBACH, 129 Broad Street, NEW YORK.

Field and Marine Glasses Revolutionized.

NEW
Bausch & Lomb-Zeiss field glass.

Field of view,
Bausch & Lomb-Zeiss Glass.

OLD
Best ordinary binocular field glass.

Bulky, Heavy, Weak.
Field of view,
Ordinary Binocular Glass.

The above is a correct comparison of the relative size and size of field of the NEW and OLD glasses of the same power. *For sale by all Opticians.*

Manufacturers: *Send for Catalogue.*

BAUSCH & LOMB OPTICAL CO., Rochester, N. Y.

12,000 in Use.

Unaffected by Weather. Portable, Self Contained.

800 to 4000

CANDLE POWER FROM

KEROSENE OIL.

Especially adapted for Repair Jobs, Work in Docks, Foundries, Boiler Shops, and elsewhere where a portable and powerful light is needed.

400 RAILROADS and over **500** CONTRACTORS NOW USE THE WELLS LIGHT.

THE WELLS LIGHT MFG. CO.,

EDWARD ROBINSON, Sole Proprietor. **46 Washington St., New York,**

BOOKS.

Every man interested in marine work should have at hand the best books devoted to the latest developments in engineering as applied to marine work.

Marine Engineering can supply them at market rates.

1878 1898

REFRIGERATION

KILBOURN

935 DREXEL BUILDING PHILADELPHIA

LIBRARY U. NOV 7 1898 S. PATENT OFFICE

MARINE ENGINEERING.

Vol. 2. NEW YORK, NOVEMBER, 1898. No. 11.

S.S. WINIFRED, THE PIONEER AMERICAN STEEL CARGO OCEAN STEAMSHIP.*

BY WILLIAM A. FAIRBURN.

The S.S. Winifred, which has just been completed by the Bath Iron Works, of Bath, Maine, is a very interesting vessel. She is the first steel tramp steamer designed and built by Americans of American material to sail under the American flag. To the enterprise of Messrs. Miller, Bull and Knowlton, of New York, managing owners of the New York and Porto Rico S.S. Company, is due the existence of this fine ship. By those who have examined her she is conceded to be superior to any cargo steamship of her size and type afloat.

The Winifred is designed as a cargo carrying, money earning steamship, and thus her model is as full as it is possible to make it, without sacrificing to any great extent economy of propulsion. The coefficient of displacement is more than .8, and the displacement is so proportioned fore and aft that the entrance and run below water are remarkably fine and easy, the midship section being almost rectangular in shape.

The following are the general dimensions of the Winifred:

Length over all	304 ft. 3 in.
Length L. W. L.	290 ft. 0 in.
Beam molded	42 ft. 0 in.
Depth molded center	25 ft. 10½ in.
Depth molded side	25 ft. 0½ in.
Load draught	20 ft. 0 in.

BROADSIDE VIEW OF OCEAN-GOING CARGO S.S. WINIFRED, WHEN LIGHT.

Least freeboard at load draught	5 ft. 0½ in.
Height between decks	8 ft. 6 in.
Gross tonnage	2,456.48 tons.
Net tonnage	1,455.83 tons.
Tonnage under decks	2,417.94 tons.
Registered length	283.5 ft.
Registered beam	42 2 ft.
Registered depth	22 1 ft.

The Winifred is a two deck steamer with topgallant forecastle, bridge and poop decks, and closed in houses connected by steel bulwarks 3 ft. 3 in. high. The distance between the main and bridge deck is 7 ft. 3 in. The vessel has a

*A brief description of the Winifred was published in our issue of January last. Since that time, however, certain modifications of design were decided upon and this will account for any apparent differences in the figures then published and those contained in this article.—Editor.

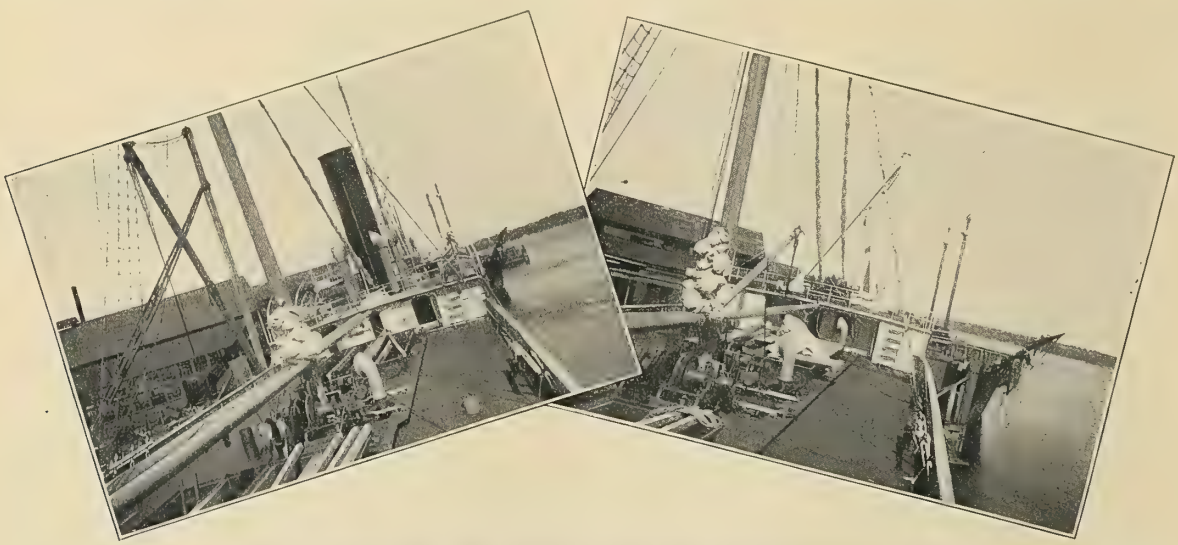
Copyright, 1898, by The Marine Publishing Co., New York.

neat pleasing sheer and a high seaworthy bow, the extreme freeboard at the bow including the forecastle being nearly 18 ft. when loaded. She has a parallel middle body of about 120 ft., a deadrise of 12 in. and a tumble home of about 3 in. A double bottom runs from the collision to the after peak bulkhead. It is constructed on the McIntire system with eleven continuous fore and aft girders resting on floors 24 in. deep. The tank is about 4 ft. deep, and the total capacity of the water bottom is 800 tons. The vessel has six complete watertight bulkheads running to the weather deck, and there are also two partial transverse bulkheads and two fore and aft coal bunker bulkheads running the complete length of the machinery spaces. The holds and 'tween decks are ceiled with 2 1-2 in. yellow pine. The lower deck is planked with 3 1-2 in. yellow pine over steel bulb tee beams, stringers and tie plates. The main deck is constructed of heavy steel plates laid over bulb angle beams 24 in. apart, and this deck is sheathed with 2 1-2 in. white pine only in the living spaces. The forecastle, poop, and bridge decks are planked with 3 in. white pine, laid over bulb angle beams, stringers and tie plates. In the forecastle are neat pipe berths for nine sailors and nine firemen, also a large carpenter's shop, water closet, wash room, vegetable lockers, ice room and oil room. In the midship house are the engine and fire room hatches, galley, pantry, state rooms for three engineers, two mates, two quartermasters, cook and steward, a large room for the captain and two passenger state rooms. There are two mess rooms for the officers in the after part, and a large saloon occupies the space at the forward end of the house, it being beautifully finished in sycamore and cherry.

The space in the poop has been fitted up for the accommodation of eighteen passengers, as it is the intention of the owners at present to run the vessel frequently to Porto Rico. Here there are nine roomy double berth state rooms with saloon, pantry and waiters' rooms. A large chart house and captain's state room is on the forward bridge deck with a bridge overhead and so arranged that the vessel can be steered either from the bridge or the chart house by hand or steam.

The Winifred has two steel pole masts with four 40 ft. cargo booms on each mast. The facilities on board for the handling and stowage of cargo are very complete. She has four unusually large hatches, viz., 26 ft. by 14 ft. at the main deck, and 26 ft. by 16 ft. at the lower deck. She is provided with leg of mutton steadying sails, the total sail area being 5,655 sq. ft.

Four boats are carried on the bridge deck; three of them are 22 ft. metallic double-ended life boats, the fourth being an 18 ft. working boat. The total cubical capacity of the four boats is 725 cu. ft., which means a carrying capacity of seventy-two men. The total number of berths on the vessel is fifty-seven, and of this number twenty-two are for the accommodation of passengers.

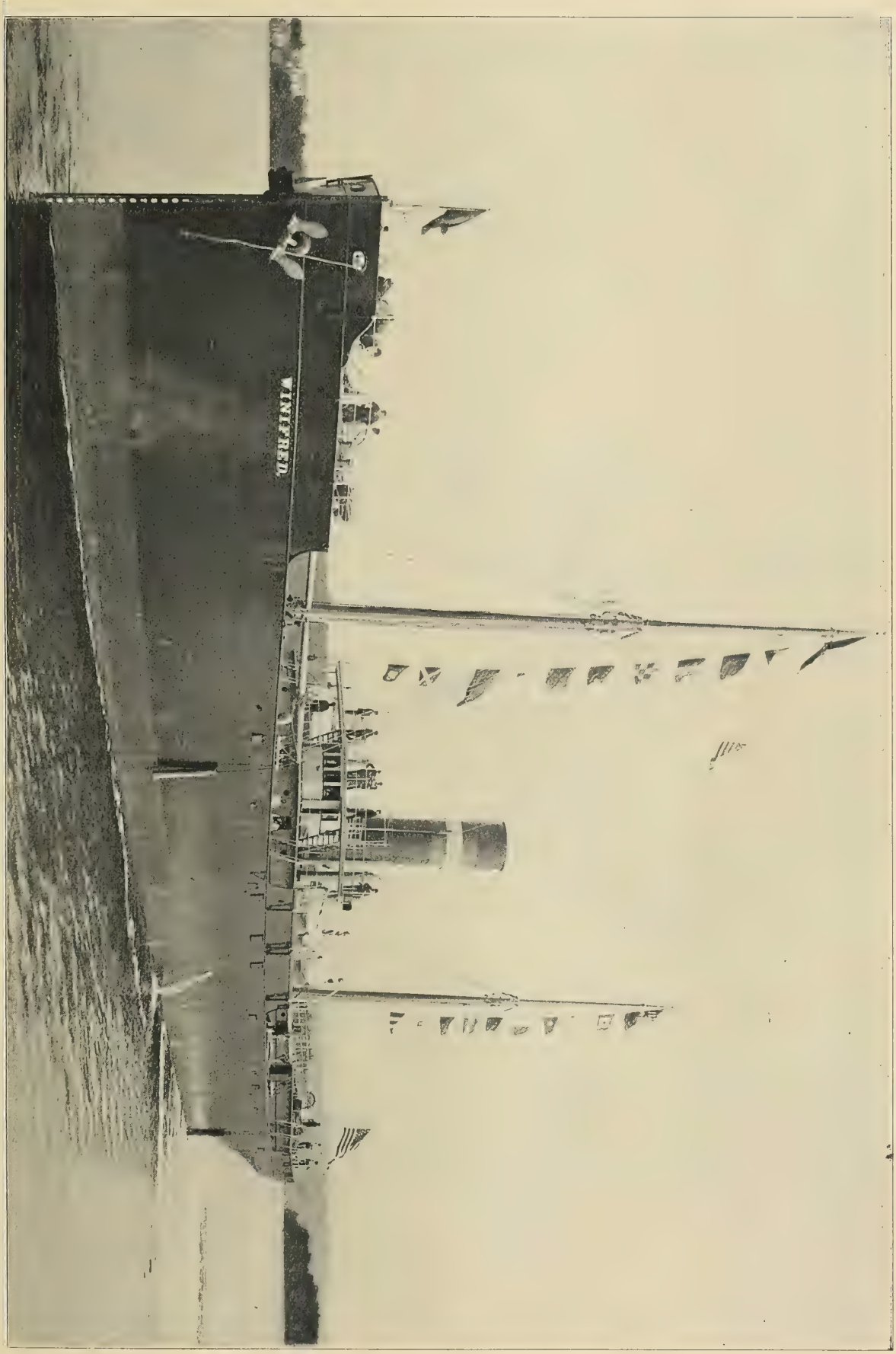


DECK VIEWS ON THE NEW CARGO STEAMSHIP WINIFRED.

The vessel has three Baldt stockless bower anchors with a weight of 4,800 lbs. each, also one stream and two Kedge anchors; 240 fathoms of 1 7-8 in. stud link chain cable and 90 fathoms of 1 in. stream chain. A Hyde steam windlass is located on the forecastle. There are four Williamson winches on the main deck, one at each hatch, and a Williamson steam steerer is located in the engine room.

The bunkers alongside the engine room are reserve bunkers, and will be often used for the stowage of cargo.

The machinery consists of a vertical triple-



AMERICAN STEEL OCEAN-GOING CARGO-CARRYING STEAMSHIP, THE WINIFRED—BUILT AND ENGINED BY THE BATH IRON WORKS, BATH, ME.

Photographed by F. V. Moody, Bath, Me.

expansion engine with cylinders 20 1-2 in., 34 in. and 55 in. dia. and 36 in. stroke designed to indicate about 1,100 I. H. P. at 100 rev. The condenser forms part of the engine framing, the cooling surface being 1,476 sq. ft. A cast iron box column on each end and an inverted Y column in the center form the support for the cylinders at the working side of the engine. The high pressure cylinder is located forward, and the low pressure aft. The high and intermediate pressure cylinders have piston valves, the latter being fitted on the side, and the low pressure cylinder has a slide valve. The intermediate and low pressure pistons are fitted with tail rods, Most of the pumps are worked from the main engine. Steam is supplied at 165 lbs. pressure by two steel Scotch boilers (single ended) of these dimensions:

Length of boiler	12 ft. 3 in.
Mean dia. boiler	12 ft. 5 in.
Distance between tube sheets	8 ft. 3 in.
Ordinary tubes 261 = 2½ in. ext. dia., No. 12 B. W. G.	
Stay tubes 52 = 2½ in. ext. dia., No. 6 B. W. G.	
Furnaces	3 Morison suspension
Inside dia. of furnaces	42 in.
Grate surface	70 sq. ft.
Length of grates	6 ft.
Tube heating surface	1,755 sq. ft.
Total heating surface	2,033 sq. ft.
Ratio G S to H S	29.04

A Scotch donkey boiler is located on the lower deck directly over the main boilers. It has a length of 9 ft. 7 1-2 in. over all, and a diameter of 6 ft. 7 1-2 in. There is one 39 in. furnace fitted with a grate 5 ft. 7 in. long. The total heating surface is 539 sq. ft., and the grate surface 17.6 sq. ft., a ratio of 30.62 to 1.

The Winifred has an ash ejector, located in the fire room. A large fan has been fitted to ventilate the stoke hole and assist the draft, but on her steam trials the fan was not used, and yet the temperature in the fire room was only 80 deg. F. and that of the engine room only 78 deg. F., a remarkable low temperature, as these compartments are well below deck.

Her endurance or radius of action is 4,500 knots with full bunkers and 2,500 knots when the reserve bunkers are used for the stowage of cargo. The propeller fitted on the Winifred during her speed test was of the following dimensions:

Diameter	13 ft. 0 in.
Pitch up to 4 ft. radius	10 ft. 11 in.
Pitch at 5 ft. 6 in. radius	11 ft. 10½ in.
Blades	4
Length of hub	23½ in.
Dia. of hub	19 in.
Max. width of blades	33 in.
Projected blade area	43.5 sq. ft.
Developed blade area	50.5 sq. ft.
Disc area	132.7 sq. ft.
Material	Cast Iron.

The following figures for capacity will be of interest:

Capacity of holds for bales	168,650 cu. ft.
Capacity of holds for grain	183,118 cu. ft.
Dead weight carried at load draft	3,800 tons.
Coal bunker capacity	450 tons.
Capacity of reserve bunker	8,600 cu. ft.

STEAM TRIALS OF S.S. WINIFRED.

The steam trials of the Winifred were conducted by the Bath Iron Works on September 26 off Southport, Maine. The vessel steamed for five hours at two-thirds and full power. She had been laying at the wharves of her builders for eighty days, and therefore her bottom was only in fair condition for a speed test. The Winifred carried on trial a load of about 600 tons, and her propeller was 19 in. out of water. This was the first time she had left the wharf under her own steam.

Following are the official figures of the technical staff which conducted the speed test:

Trial draught, forw'd	6 ft. 5 in.
Trial draught aft	12 ft. 3 in.
Trial draught, mean	9 ft. 4 in.
Speed in knots	11.25
Slip per cent	10.53
Disc area, wheel on trial, sq. ft.	123.7
Area mid section ÷ disc area	2.95
Projected blade area, wheel on trial, sq. ft.	40.5
Developed blade area, wheel on trial, sq. ft.	48
Revolutions	10.3
Max. piston speed, ft.	644
Steam pressure, boilers, lb.	160
Steam pressure, I. P. rec., lb.	40
Steam pressure, L. P. rec., lb.	4
Vacuum, in	21.5
M. E. P. H. P. Cyl., lb.	79
M. E. P. I. P. Cyl., lb.	22.42
M. E. P. L. P. Cyl., lb.	6.75
Equivalent referred to L. P. Cyl.	26.32
I. H. P. H. P. Cyl.	509
I. H. P. I. P. Cyl.	390
I. H. P. L. P. Cyl.	313
I. H. P. total	1,212
Indicated thrust, lb.	31,380
Indicated thrust, per sq. in. developed blade area, lb.	4.54
Indicated thrust, per sq. ft. projected blade area, lb.	5.38
Heating surface in sq. ft. per I. H. P.	3.35
Cooling surface in sq. ft. per I. H. P.	1.18
I. H. P. per sq. ft. grate surface, nat. draft.	8.66

A run over the measured mile gave a speed of 11.16 knots against the tide with 1,207 I. H. P., and against a very strong wind—which had a very detrimental effect on this high sided boat, the freeboard on trial being over 30 ft. forward—the speed on another occasion was 10.8 knots with about 1,100 I. H. P. The average cruising speed was over 10 1-4 knots, with 96 rev. and 900 I. H. P. Throughout the trial the machinery was never once forced, and no attempt was made to obtain high power or speed, but the trial proved beyond a doubt that the machinery is capable of developing at least 1,400 I. H. P. when assisted by the fan, and that the sustained power will be at least 1,100 I. H. P. The rate of speed of the Winifred when light, with assisted draft will be 12 knots, and when deeply loaded at sea 10 1-2 knots. She has therefore proved herself to be one of the fastest vessels of her size and type afloat.

CONSTRUCTION OF THE NEW U. S. COMPOSITE GUNBOATS WITH A COMPARISON OF THEIR PERFORMANCES.

The six cruising gunboats, officially known as numbers 10 to 15, authorized by act of Congress and approved March 2, 1895, marked a new era in the constructive practice of our modern navy, and increased to nine our fleet of small craft especially designed for police duty in the rivers and shallow estuaries of China, and in the waters of the revolutionary Central and South American Republics.

These vessels are of composite construction, advocated by Chief Constructor Hichborn, and the strong features of their design are great sea keeping power, with minimum running expenses and initial cost, good fighting ability on a small displacement, good sea speed without constant docking, for the copper sheathing will prevent fouling, and, in the case of numbers 10 to 13 remarkable endurance and cruising power, for these four vessels have full sail power. Gunboats 10 to 13 are the "Annapolis," "Vicksburg," "Newport" and "Princeton," respectively. They are of the single-screw type with full sail power. The "Annapolis" was built by Lewis Nixon at the Crescent Shipyard, Elizabethport, N. J. The contract was signed November 20, 1895; she was launched December 23, 1896, and she steamed on her official trial April 22, 1897. The "Vicksburg" and "Newport" were built by the Bath Iron Works, of Bath, Me.; the contract for these vessels was signed November 15, 1895. They were both launched together, December 5, 1896, and the official speed trials took place May 29 and May 27, 1897, respectively. The "Princeton" was contracted for by J. H. Dialogue & Sons, Camden, N. J., on November 20, 1895. Her keel was laid six months later, and the construction of this vessel was so slow that she was only comparatively recently turned over to the government by her builders.

The hulls and general characteristics of these four vessels are supposed to be identical. The following are their general dimensions and particulars of form:

Length over all	204 ft.
Length L. W. L	168 ft.
Beam	36 ft.
Ratio of L. to B	4.66
Depth to spar deck	22 ft. 3½ in.
Mean draught	12 ft.
Normal displacement	1,010 to 1,017 tons
Tons per inch of immersion at L. W. L	10.73
Area of immersed mid-section	356 sq. ft.
Area of load-water plane	4,510 sq. ft.
Metacentric height—G. M.	4.07 ft.
Co-efficient of displacement	.485
Prismatic co-efficient	.59
Mid-section co-efficient	.82
L. W. plane co-efficient	.74

These vessels, as before mentioned, are of composite construction, with steel plating above and wood planking below the water line. They have a flush spar deck with hammock berthing amidship, a gun deck with offices and cabins at the after end, and a berth deck forward and aft of the machinery spaces. There is a double bottom under the engines and boilers which can be used for the stowage of fresh water. The bulkheads on ten frames are made watertight below the gun deck, as are also the coal bunkers, store rooms and hold. There is no protective deck, but the coal bunkers which surround the machinery spaces extend to the gun deck, which is a good distance above the load water line, and give good protection when full. There is a trimming tank at each extremity of these vessels and each is divided into twenty-eight watertight compartments. These vessels are barkentine rigged, the area of the nine principal sails being 11,253 sq. ft. They each carry seven boats, including a steam cutter. The main battery consists of six 4-in. R. F. guns, and the secondary battery is made up of four 6-pounders and two 1-pounder R. F. guns. There are no torpedo tubes. The contracts required an average speed of 12 knots for four consecutive hours, subject to a penalty at the rate of $10,000 per knot for a less speed. There was no premium for excess of speed or I. H. P. As the "Princeton's" trial cannot be recorded in this article we will neglect this vessel and briefly describe the machinery of her three sisters.

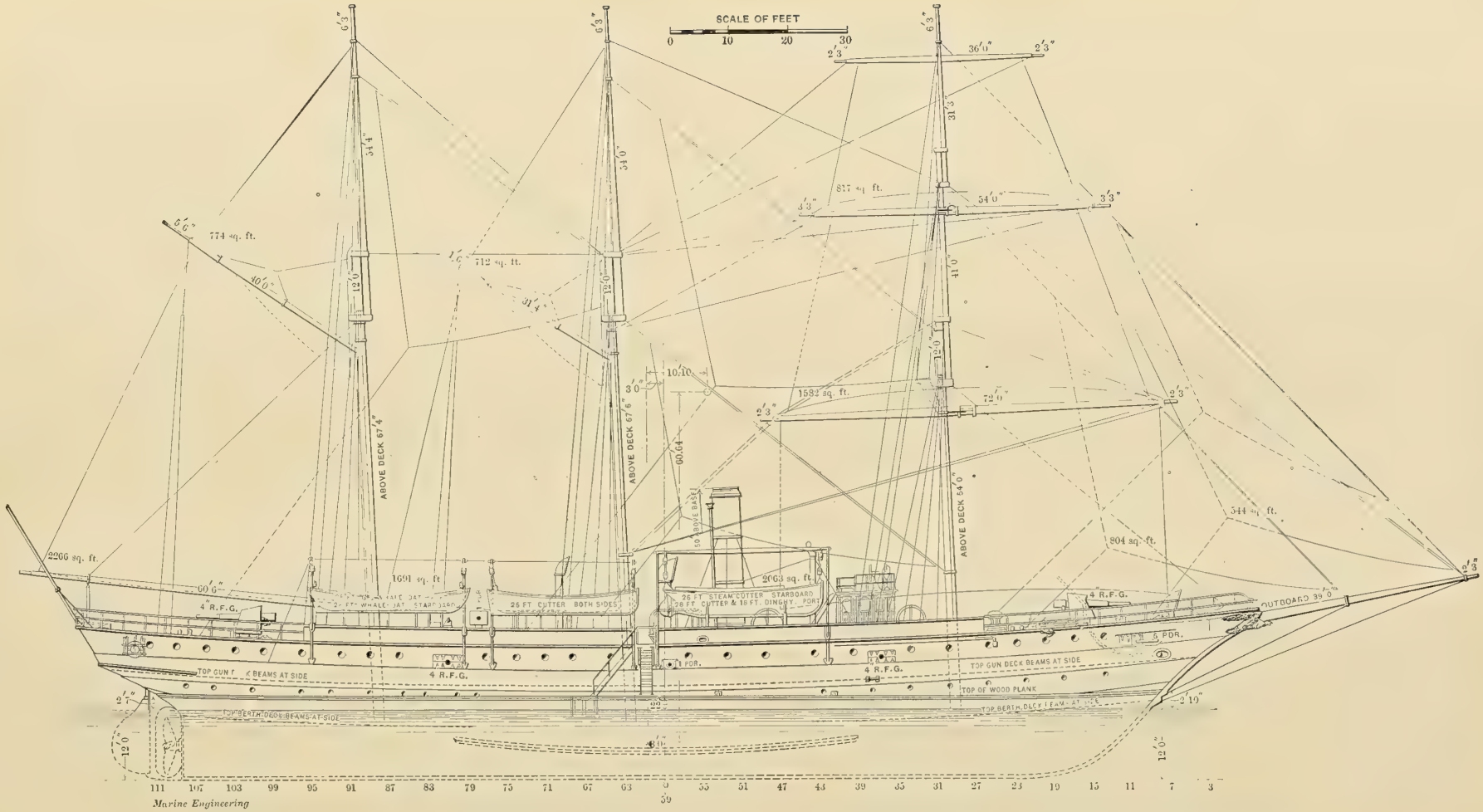
The "Newport" and "Vicksburg" have two single-ended horizontal return fire-tube boilers. each with two corrugated furnaces:

Length	10 ft. 6 in.
Diameter	10 ft. 6 in.
Diameter of furnaces	{ Min., 36 in. Max., 39 in.
Length of grate	6 ft. 6 in.
Number of ordinary tubes	132
Number of stay tubes	64
Outside diameter of all tubes	2¾ in.
Length between tube sheets	7 ft. 6 in.
Tube-heating surface	1,058.4 sq. ft.
Total heating surface	1,262 sq. ft.
Grate surface	39 sq. ft.
Ratio grate surface to H. S	1 to 32.06
Area through tubes	6.23
Normal steam space	166 cu. ft.
Total H. S. of two boilers	2,524 sq. ft.
Total G. S. of two boilers	78 sq. ft.

The forced draft is supplied by two Sturtevant blowers which discharge under the brick wall into the back of each ash pan.

There are eight coal bunkers, the total capacity being 240 tons.

The "Newport" and "Vicksburg" have each a single screw engine of the vertical triple-expansion type, designed to indicate 800 I. H. P. at 150 revolutions per minute. It is arranged in the usual manner with the H. P. cylinder forward, the cranks being 120 deg. apart and following in the order H. P., I. P. and L. P., the cranks turning to port from the top center. The cylinders are jacketed on top and sides. The H. P. cylinder has a piston valve whilst the I. P. and L. P. cylinders have double ported slide valves. The valve gear is the ordinary Stephenson link-motion with double bar links. The condenser is separate from the engine and the air pump is worked from the L. P. crosshead.



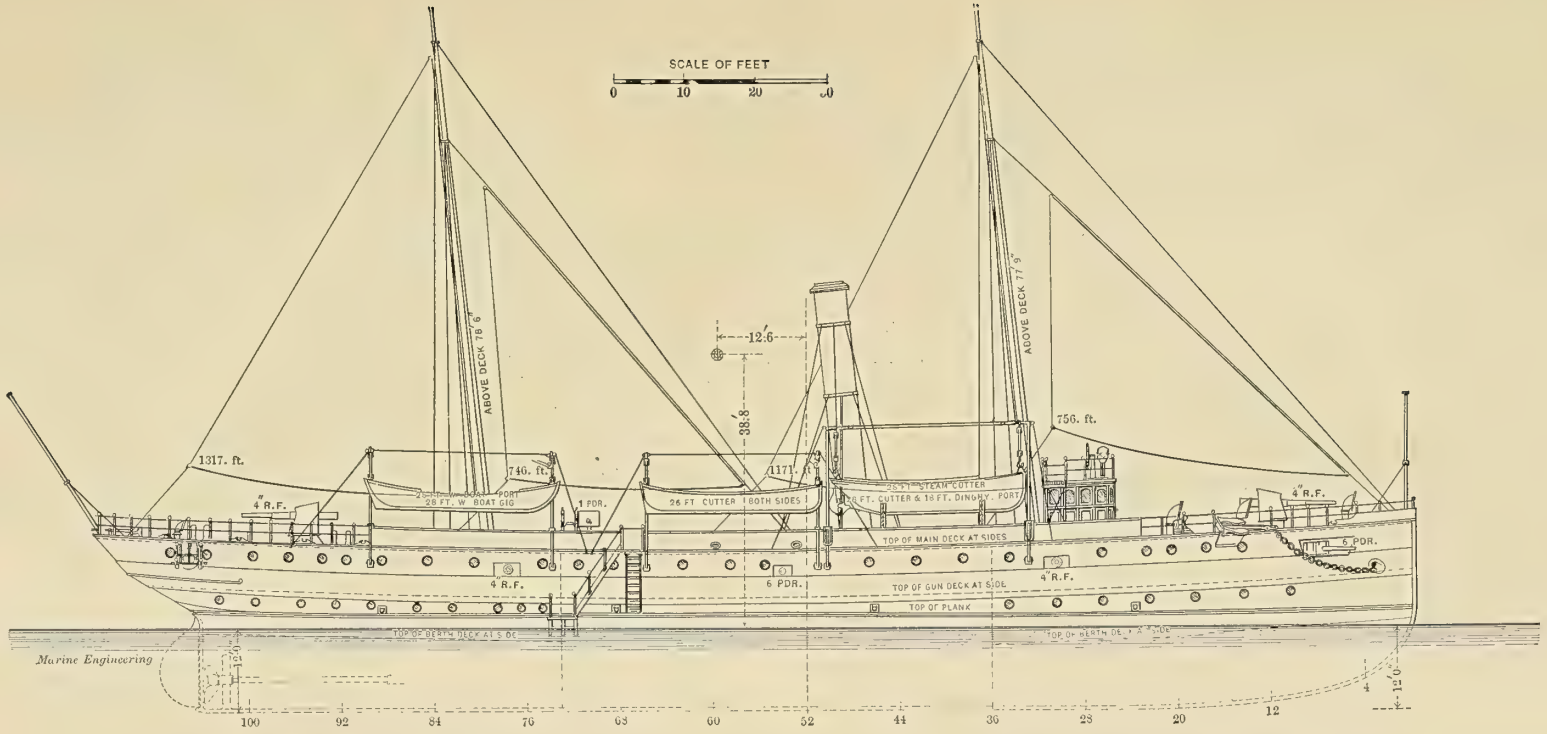
SAIL PLAN OF THE U. S. COMPOSITE GUNBOATS 10 TO 13—ANNAPOLIS, VICKSBURG, NEWPORT AND PRINCETON.

The following are some of the principal dimensions and particulars of these engines:

Diameter of cylinders	15¼, 23½, 36 in.
Stroke	30 in.
Ratio of net areas of pist ns H. P. to I. P	5.57
Propeller	Left-handed, three-bladed, bronze
Diameter of propeller	10 ft.
Pitch "Vicksburg"	10.627 ft.
Pitch "Newport"	10.453 ft.
Condenser	Cylindrical steel plate, bronze ends
Cooling surface	1,118 sq. ft.
Length between tube sheets	7 ft. 3 in.
Number of tubes	942
Auxiliary condenser	150 sq. ft.

The auxiliary machinery includes an electric plant, ventilation system, Hyde steam windlass, Hyde double hoisting engine, Williamson steering engine and workshop machinery.

The machinery of the "Annapolis" consists of a vertical single screw triple-expansion engine with cylinders 15 in., 24 1-2 in. and 40 in. dia. and 28 in. stroke. This engine was designed to



SAIL PLAN OF THE U. S. COMPOSITE TWIN-SCREW GUNBOATS NOS. 14 AND 15—WHEELING AND MARIETTA.

develop over 800 I. H. P. when running at 160 rev. with a steam pressure of 200 lbs. at the boilers. The ratio of net area of pistons H. P. to L. P. = 7.11. The propeller is solid four-bladed, bronze, true screw 9 ft. 6 in. dia. and 11 ft. pitch. The condenser forms part of the engine framing and is of cast iron with 124.1 sq. ft. of cooling surface. The auxiliaries are very similar to those fitted on gunboats Nos. 11 and 12. The "Annapolis" differs, however, from the Bath built sisters in her boiler plant. She is fitted with two Babcock & Wilcox water-tube boilers of these dimensions:

Length	11 ft. 7 in.
Width	9 ft. 6 in.
Height	11 ft.
Boiler-heating surface	1,575 sq. ft.
Heater H. S.	235 sq. ft.
Grate surface	49 sq. ft.
Total H. S. two boilers	3,620 sq. ft.
Total G. S.	98 sq. ft.
Ratio G. S. to H. S	1 to 37

Gunboats Nos. 14 and 15 are the "Wheeling" and "Marietta." They are composite twin-screw gunboats of 12 knots speed, and fitted only with steadying sails. They were built by the Union Iron Works, of San Francisco. The contract for these vessels was signed November 26, 1895. The keels were laid in April of the following year, and they were launched together March 18, 1897; the vessels steaming on their official trials May 29 and May 26, 1897, respectively, or exactly the same time as the two Bath built single-screw gunboats.

The general arrangement and construction of the hulls of these vessels closely resemble the

gunboats previously described. The following are the principal dimensions and features of the hulls of the "Wheeling" and "Marietta":

Length over all	189 ft. 7 in.
Length L. W. L.	174 ft.
Beam	31 ft.
Ratio of L. to B	5.12 to 1
Depth at side	22 ft. 7¾ in.
Mean draught	12 ft.
Displacement	996 tons
Tons per inch immersion at L. W. L.	10.13
Area of mid-section immersed	338 sq. ft.
Area of L. W. plane	4,284 ft.
Co-efficient of displacement	.508
Mid-section co-efficient	.858
L. W. P. co-efficient	.724
Wetted surface	6,495 sq. ft.

The hulls of these vessels below the main deck are divided into 42 watertight compartments, including the double bottom.

The twin-screw engines are of the vertical triple-expansion type, placed in a common compartment with the H. P. cylinder forward. These engines were designed to develop 400 I. H. P. each when running at 200 rev. with 180 lbs. of steam in the boilers. The following are a few of the most important dimensions and particulars of the engines, etc.:

Diameter of cylinders	12, 18 and 28 in.
Stroke	18 in.
Ratio of net area of pistons H. P. to L. P	5.93
Propeller	Three-bladed, solid bronze
Hand	Starboard left and the port right
Diameter of propellers	6 ft. 9 in.
Pitch	7 ft. 3 in.
Condensers	Composition, oval section
Length of tubes of condensers	8 ft. 6 in.
Number of tubes	404
Cooling surface each condenser	552 sq. ft.
Auxiliary condenser	4 ft 7 in. long
Diameter auxiliary condenser	18 in.
Cooling surface of auxiliary condenser	150 sq. ft.

The "Wheeling" is fitted with two single-ended horizontal cylindrical steel boilers:

Length	10 ft. 6 in.
Diameter	10 ft. 6 in.
Furnaces (two)	Min. dia., 36 in. Max. dia., 40½ in.
Number of ordinary tubes	130
Number of stay tubes	64
Diameter of all tubes outside	2¾ in.
Length between tube sheets	7 ft. 6 in.
Heating surface each boiler	1,254 sq. ft.
Grate surface each boiler	30 sq. ft.
Total heating surface, two boilers	2,508 sq. ft.
Total G. S., two boilers	60 sq. ft.
Ratio H. S. to G. S	41.3
Area through tubes	12.34 sq. ft.

Forced draft is fitted on the well-known Howden system.

The original design of the "Marietta" and also that of the "Annapolis" called for two cylindrical boilers similar to those installed in the "Wheeling," but at the request of the contractors two Babcock & Wilcox water-tube boilers were substituted. The boilers in the "Marietta" are exactly the same as those placed in the "Annapolis," as previousy described. The "Marietta" carries 247 tons of coal in her bunkers and the "Wheeling" about the same. The gunboats "Newport," "Vicksburg," "Wheeling" and "Marietta" were officially tried on the standardizing screw method. By this method the vessels are run over a certain measured base and curves of I .H. P. revolutions and speed are accurately plotted. The vessels then steam at sea for a period of four hours, and the mean number of revolutions being obtained for this period the speed corresponding to this number of revolutions can be readily obtained. It is, of course, necessary that the draught and trim of the vessel is the same on the progressive trial on the base as it is on the sea run. The "Newport" and "Vicksburg" had progressive speed trials on the Bath Iron Works measured nautical mile course off Southport, Me., it having been officially measured; for the four hours sea trial the vessels were headed out to sea. The "Wheeling" and "Marietta" were tried over a measured base of 6,138 ft. off Bluff Point in San Francisco Bay. The "Vicksburg" and "Newport" were tried under ordinary weather conditions. The progressive runs of the "Wheeling" were made at low speed during a comparative calm, whilst those of the "Marietta" were made in a fresh breeze; at the higher speeds the conditions were exactly reversed.

PROGRESSIVE SPEED TRIALS OF U. S. S. VICKSBURG.

Run.	Speed Knots	Rev. per M.	Total I.H.P.
1	12.676	144.4	1,103.40
2	12.456	144.95	1,062.22
3	12.544	142.5	1,032.61
4	12.361	142.8	1,030.13
5	12.06	134.38	866.58
6	11.746	132.68	825.33
7	11.603	127.27	722.54
8	11.268	127.14	710.25
9	10.666	115.55	535.71
10	10.375	115.21	524.36

PROGRESSIVE SPEED TRIALS OF U. S. S. NEWPORT.

1	11.755	141.65	1,008.71
2	12.51	138.89	951.13
3	11.58	136.82	925.84
4	12.326	138.93	941.35
5	11.613	138.92	959.55
6	12.255	136.85	905.04
7	11.193	131.8	839.09
8	11.379	127.2	688.77
9	10.056	116.06	552.07
10	10.810	117.08	564.34

PROGRESSIVE SPEED TRIALS OF U. S. S. WHEELING.

1	8.719	117	133.12
2	5.893	125	168.76
3	10.919	158	314.44
4	7.956	157	306.9
5	11.506	179	451.93
6	9.469	178	473.06
7	11.096	177	459.99
8	9.989	181	477.04
9	10.242	199	650.82
10	12.582	2 0	648.94
11	9.989	199	650.06
12	12.713	203	689.77
13	11.292	224	953.89
14	13.825	228	991.38
15	11.654	228	1,022.25
16	13.669	227	1,003.63

PROGRESSIVE SPEED TRIALS OF U. S. S. MARIETTA.

1	5.568	118	136.89
2	8.062	112	127.90
3	7.074	143	243.30
4	10.10	149	280.06
5	12.452	184	514.62
6	8.89	182	475.83
7	12.242	180	461.27
8	8.906	181	497.78
9	13.126	204	677.81
10	10.789	210	749.73
11	13.080	210	741.44
12	11.222	209	731.30
13	12.452	229	981.55
14	13.367	231	1,024.52
15	12.939	236	1,069.88
16	13.032	231	1,059.01

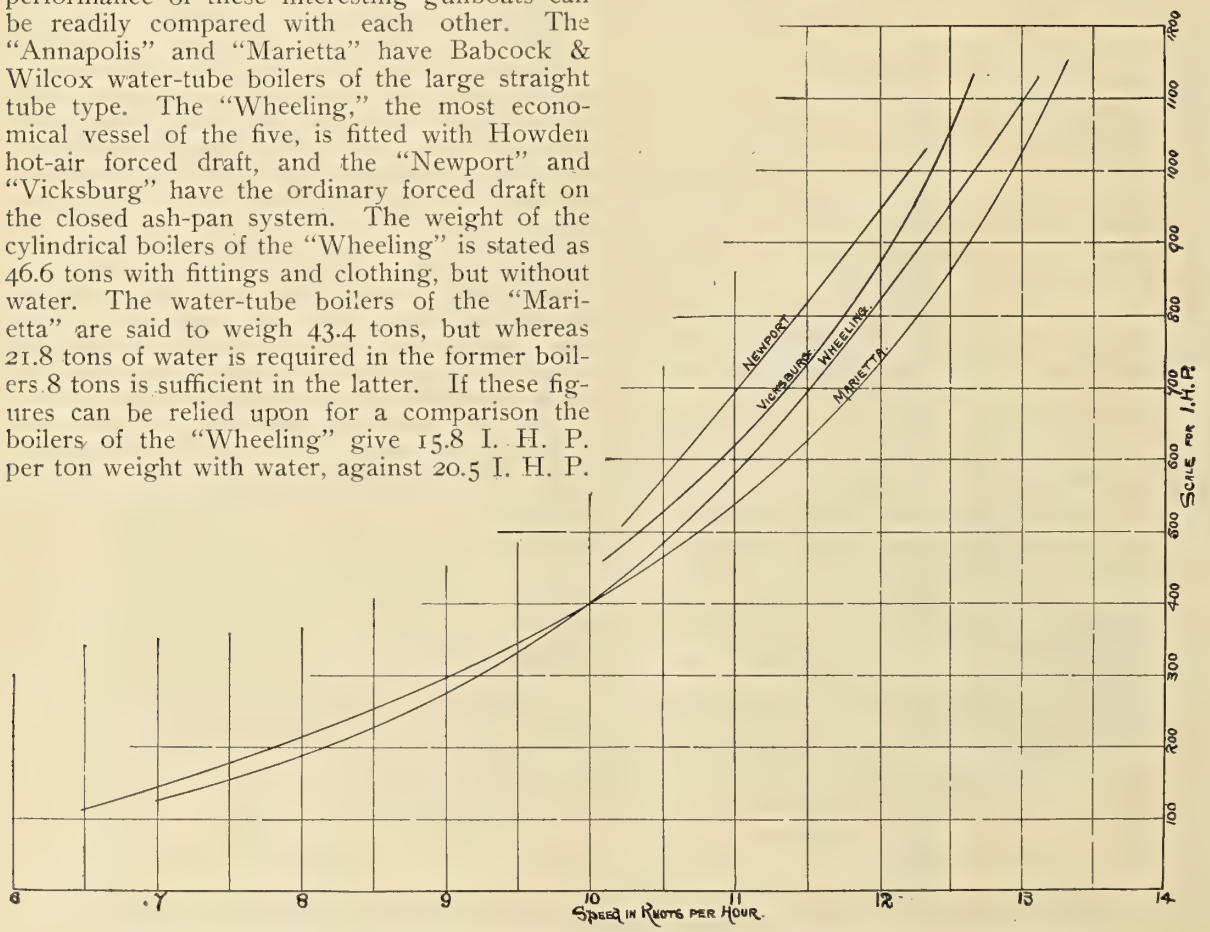
BROADSIDE VIEW OF THE ANNAPOLIS CLASS OF U. S. COMPOSITE GUNBOATS.

BROADSIDE VIEW OF THE WHEELING CLASS OF TWIN SCREW COMPOSITE GUNBOATS.

CONTRACT TRIAL DATA, FOUR HOURS' SEA RUN, U. S. COMPOSITE GUNBOATS.

	Newport	Vicksburg.	Annapolis.	Wheeling.	Marietta.
Mean trial draught, feet	11.8½	11.7¾	11.5	12.0⅜	11.11½
Mean trial displacement, tons	972	964	943	1,000	991
Area mid-section, sq. ft	344	342	333	352	349
Area wetted surface, sq. ft	7,060	7,040	6,980	7,300	7,250
Speed, knots	12.29	12.71	13.172	12.88	13.02
Slip, per cent	16.49	17.39	17.3	22.2	21.5
$\frac{D^{\frac{2}{3}} \times V^3}{I. H. P.}$	183.9	181.5	179.76	202.2	213
$\frac{A \times V^3}{I. H. P.}$	644.8	636.3	622.49	747.8	711.6
I. H. P. per 100 square feet W. S	14.03	15.68	17.51	14.5	14.2
Revolutions, mean	142.68	146.57	146.76	231.4	231.8
Piston speed, feet	713.40	733.85	684.88	694.2	695.4
Steam pressure boilers	182	186	224.7	182	173.6
Vacuum, inches	25.5	26.3	24	26.7	26.25
Air pressure in ash pan, inches	.95	.97	.9	.78	.36
M. E. P. referred to L. P. cylinder	45.04	48.57	46.47	42.74	40.5
I. H. P. main engines	976	1,084	1,207	1,051	1,024
I. H. P., collective	1,009	1,118	1,227	1,080	1,054
Indicated thrust, pounds	16,021	18,513	24,685	20,625	20,102
Indicated thrust per square inch of developed blade area	4.75	5.5	5.72	4.2	4.1
Square feet of cooling surface per I. H. P	1.13	1.01	1.02	1.04	1.07
Square feet of H. S. per I. H. P	2.50	2.26	2.95	2.32	3.48
I. H. P. per square foot G. S	12.93	14.34	12.52	18	11.2
I. H. P. per ton machinery penalty weight	8.89	9.85	9.35	9.34	10.15
Coal burnt per hour, pounds	2,065	2,375	3,580	1,855.5	2 300
Coal per I. H. P. per hour, pounds	2.05	2.12	2.91	1.72	2.18
Coal per square foot G. S., pounds	26.48	30.45	36.53	30.92	23.47
Quality of coal	Pocahontas	Pocahontas	Pocahontas	Good Harris	Navigation

The coal consumption test of the "Annapolis" was not very carefully conducted and the above figures represent the return run over a 24-mile course off Bridgeport, Conn. These results should be questioned. The foregoing figures are arranged in tabular form so that the trial performance of these interesting gunboats can be readily compared with each other. The "Annapolis" and "Marietta" have Babcock & Wilcox water-tube boilers of the large straight tube type. The "Wheeling," the most economical vessel of the five, is fitted with Howden hot-air forced draft, and the "Newport" and "Vicksburg" have the ordinary forced draft on the closed ash-pan system. The weight of the cylindrical boilers of the "Wheeling" is stated as 46.6 tons with fittings and clothing, but without water. The water-tube boilers of the "Marietta" are said to weigh 43.4 tons, but whereas 21.8 tons of water is required in the former boilers 8 tons is sufficient in the latter. If these figures can be relied upon for a comparison the boilers of the "Wheeling" give 15.8 I. H. P. per ton weight with water, against 20.5 I. H. P. per ton weight of the water-tube boilers. The accompanying speed curves graphically show the relative performances of the four vessels which were given progressive trials, these results having been plotted from the figures given in the proceeding tables.



SPEED CURVES SHOWING THE PERFORMANCES ON PROGRESSIVE TRIALS OF FOUR U. S. COMPOSITE GUNBOATS.

HIGH PRESSURE AT SEA WITH SOME CONSIDERATION OF TYPES OF BOILERS.*—VI.

BY W. R. CUMMINS.

[*Last Installment.*]

In order to compare the turning moments of the different types of engine, both three and four crank, Figs. 4 to 9 have been prepared. The different types of engine represented have all the same area of low-pressure cylinder or cylinders, the same stroke, number of expansions and revolutions. Also approximately the same mean pressure referred to the low-pressure cylinder. Hence the mean turning moment will be approximately the same for each type. The pressures have been taken from diagrams constructed to be as nearly like the actual diagrams as possible.

The inertia of the moving parts has been calculated on the assumption that the angular velocity of the crank shaft is constant. The weight of the moving parts has been proportioned to the initial load, and the pistons have been taken as of ordinary cast-iron design.

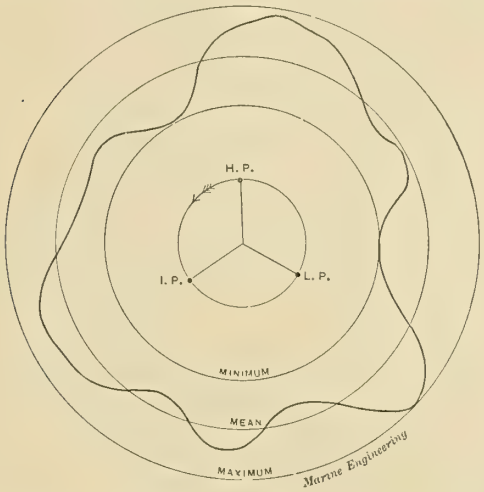


Fig. 4

3 Cylinder, 3 Stage.
15½ × 26½ × 49.
Revs. = 75.
Equal initial loads.

Turning Moments.
Maximum > Mean, 30 per cent.
Minimum < Mean, 26 per cent.
Total variation, 56 per cent.

From these diagrams we see that the engines which give the most equable turning moment are the four-cylinder two-stage and the four-cylinder four-stage, with a variation of 14 per cent above the mean turning moment and 34 per cent below for the two-stage, and 23 per cent above and 27 per cent below for the four-stage.

Taking into account all these facts as to initial load, cuts-off, drop and turning moment, it would appear that for ordinary work the three-cylinder three-stage type is the most suitable, if three cranks are to be used, as it has less total initial load, more equal cuts-off, less loss from drop, and a more equable turning moment than the two-stage three-cylinder type. If four cranks are desired, the most suitable arrangement for ordinary mercantile work is the four-stage four-cylinder arrangement, as it has less initial load, more equal cuts-off, less loss from drop and a more equable turning moment than the three-stage four-cylinder type.

Fig. 9 shows the disastrous effect on the turning moment with unequal initial loads. In the diagram shown the initial loads in each of the two low-pressure cylinders are one-half the load on the high-pressure and intermediate-pressure. The result is that the maximum turning moment is 39 per cent greater than the mean, and the minimum 60 per cent less than the mean, giving a total variation of 99 per cent.

For navy engines the two-stage four-cylinder type has many advantages to recommend it. It has less initial load than any of the other arrangements. The cuts-off are not equal, but with the fewer total expansions required by navy engines the cut-off in the low-pressure would be sufficiently late to give enough valve opening. The loss from drop is more than in the other types, but is not of such importance in the case of navy engines. The turning moment is more equable than any of the other types, and as the maximum moment is only 14 per cent more than the mean, whereas in the three-stage four-cylinder type with unequal initial loads it is 39 per cent more than the mean, it follows that the shafting may be reduced in size no less than 25 per cent. The arrangement is practically two compound engines, and in the event of damage to either of the cylinders or gear the engine affected could be shut off without interfering with the working

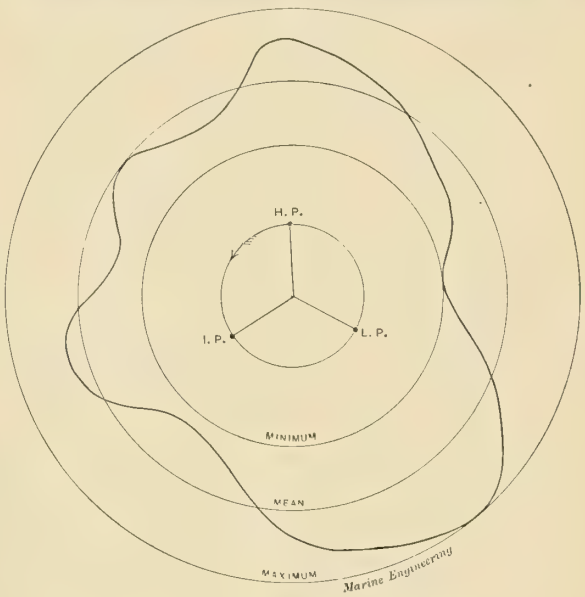


Fig. 5

3 Cylinder, 2 Stage.
15½ × 34½ × 34½.
Revs. = 75.
Equal initial loads.

Turning Moments.
Maximum > Mean, 33 per cent.
Minimum < Mean, 29 per cent.
Total variation, 62 per cent.

*From a paper read at the North-East Coast Institute of Engineers and Shipbuilders in Sunderland, England.

of the other. Still greater advantages could be obtained by using four cylinders of different size, to be used as a four-stage arrangement for cruising and as a two-stage arrangement for full power. In reference to the most suitable general arrangement of engine, the author stated that in the three-crank engine there is not much

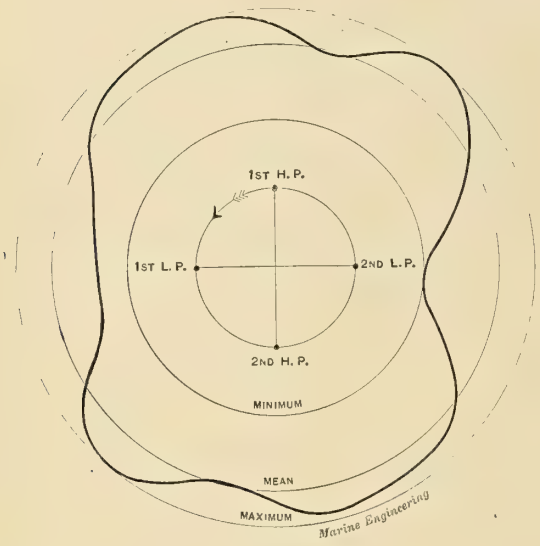


Fig. 6

4 Cylinder, 2 Stage.

11 × 34½ × 11 × 34½.
Revs. = 75.
Equal initial loads.

Turning Moments.

Maximum > Mean, 14 per cent.
Minimum < Mean, 31 per cent.
Total variation, 45 per cent.

pressure aft; valve chests all looking forward, two short ends of crank shaft between high pressure and intermediate pressure; two long ends or a short and a long between intermediate pressure and low pressure; intermediate pressure eccentrics on couplings. (2) High pressure in center, intermediate pressure forward, and low pressure

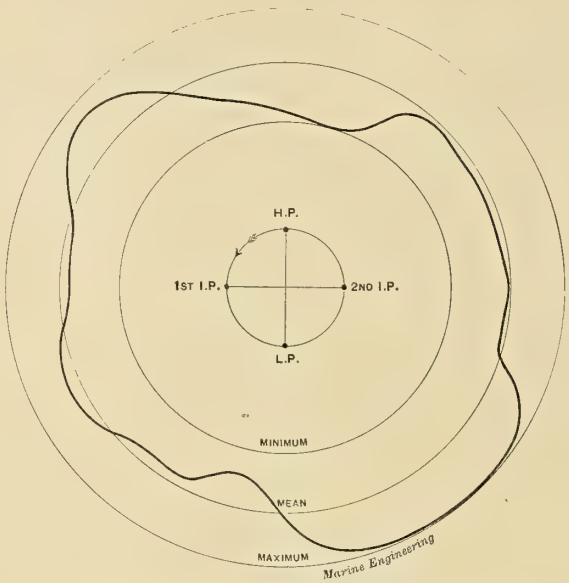


Fig. 7

4 Cylinder, 4 Stage.

15½ × 22 × 32 × 49.
Revs. = 75.
Equal initial loads.

Turning Moments.

Maximum > Mean 23 per cent.
Minimum < Mean, 27 per cent.
Total variation, 50 per cent.

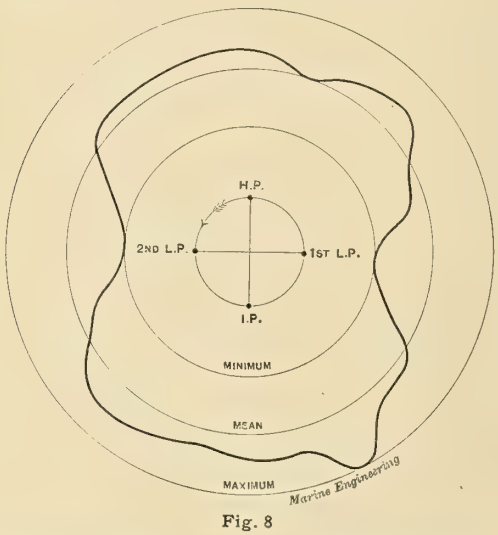


Fig. 8

4 Cylinder, 3 Stage.

15½ × 25½ × 34½ × 34½
Revs. = 75.
Equal initial loads.

Turning Moments.

Maximum > Mean, 30 per cent.
Minimum < Mean 33 per cent.
Total variation, 63 per cent.

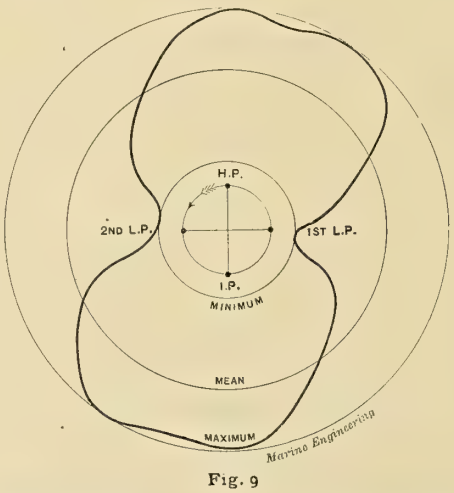


Fig. 9

4 Cylinder, 3 Stage.

15½ × 25½ × 34½ × 34½.
Revs. = 75.
Unequal initial loads.

Turning Moments.

Maximum > Mean, 39 per cent.
Minimum < Mean, 60 per cent.
Total variation, 99 per cent.

to choose between the three typical designs into which the triple expansion engine with six bearings and three interchangeable cranks has fallen, viz.: (1) High pressure forward, intermediate pressure in center, and low

aft; high pressure piston valve and intermediate slide valve in one chest between the cylinders, low pressure slide valve forward of cylinder; short and long length of crank shaft between high pressure and intermediate pressure, also between in-

termediate pressure and low pressure; high pressure eccentrics on couplings; and (3) the Admiralty design, high pressure forward, intermediate pressure in center, and low pressure aft; high pressure valve forward, intermediate pressure valve forward, low pressure valve aft of cylinder; short and long lengths of crank shaft between high pressure and intermediate pressure, two short lengths between low pressure and intermediate pressure; no eccentrics on couplings.

In the four-crank engine the great object will be to save fore and aft space, and some endeavor should be made to reduce as far as possible the be off the center line of the engine, and if the first and second cylinders are fitted with piston valves, there is no reason why they should not be arranged in that manner. If the two after cylinders and the two forward cylinders have their cranks opposite one another, and if the cuts-off in each cylinder are equal, or nearly equal, then only two sets of valve gear are required, and they may be put together in the center of the engine, thus reducing the length of the reversing shaft to minimum. The slide valves of the two center engines would look towards one another, and the piston valves at the back of the engines

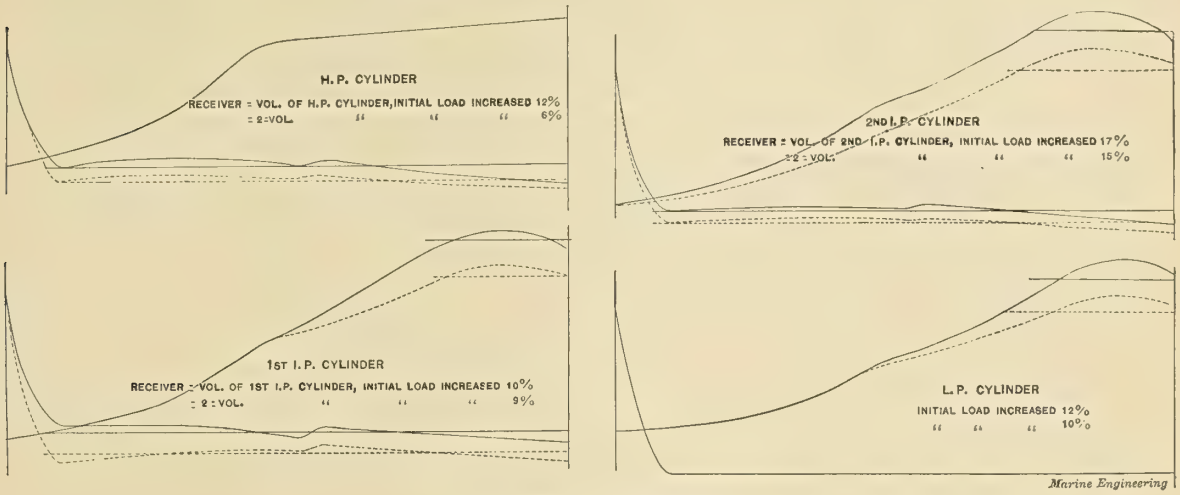

H. P. CYLINDER
RECEIVER = VOL. OF H.P. CYLINDER, INITIAL LOAD INCREASED 12%
= 2 = VOL. " " " 6%
2ND I. P. CYLINDER
RECEIVER = VOL. OF 2ND I.P. CYLINDER, INITIAL LOAD INCREASED 17%
= 2 = VOL. " " " 15%
1ST I. P. CYLINDER
RECEIVER = VOL. OF 1ST I.P. CYLINDER, INITIAL LOAD INCREASED 10%
= 2 = VOL. " " " 9%
L. P. CYLINDER
INITIAL LOAD INCREASED 12%
" " " 10%
Marine Engineering

Fig. 10.—Cranks at right angles.

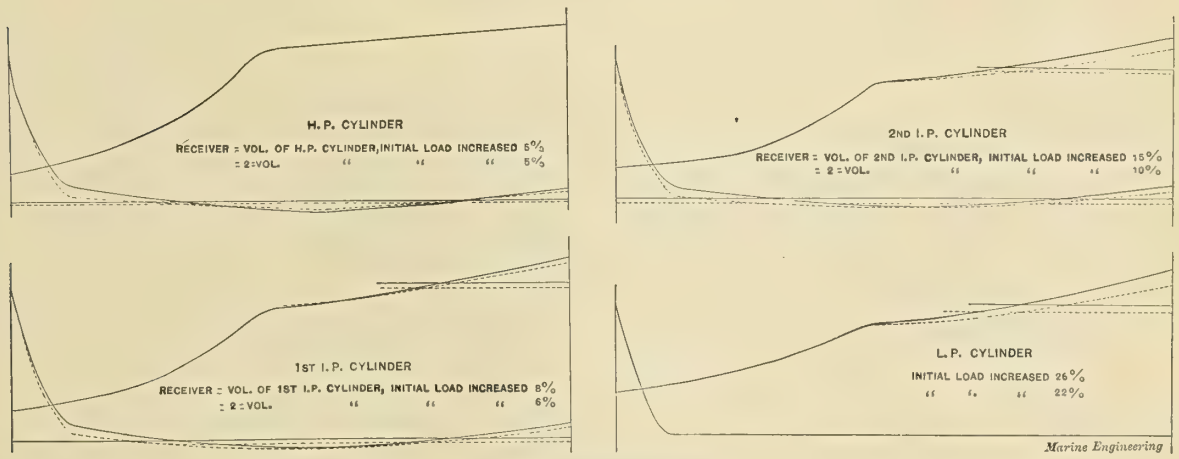

H. P. CYLINDER
RECEIVER = VOL. OF H.P. CYLINDER, INITIAL LOAD INCREASED 8%
= 2 = VOL. " " " 8%
2ND I. P. CYLINDER
RECEIVER = VOL. OF 2ND I.P. CYLINDER, INITIAL LOAD INCREASED 15%
= 2 = VOL. " " " 10%
1ST I. P. CYLINDER
RECEIVER = VOL. OF 1ST I.P. CYLINDER, INITIAL LOAD INCREASED 8%
= 2 = VOL. " " " 6%
L. P. CYLINDER
INITIAL LOAD INCREASED 26%
" " " 22%
Marine Engineering

Fig. 11.—Cranks opposite.

number of bearings and working parts. For instance, the crank shaft may be in two pieces only, interchangeable. By doing this six main bearings only are required, provided the two forward cranks and the two after cranks are arranged opposite one another, to take the greater part of the stress off the bearings between the two forward cylinders and the two after cylinders. Then, if the length of the engines is not to exceed the length of the three-crank engines, two of the valves must would be worked by rocking shafts, worked by levers and links from the slide valve rods. There is a prejudice against having valves off the center line of the engines, no doubt justified when a heavy slide valve is worked by an overhung pin; such an arrangement is bound to give trouble, owing to the want of stiffness of the overhung pin; but there can be no objection mechanically to a piston valve worked in that manner, provided there are no overhung pins. It should be men-

tioned here that the above arrangement, with the two opposite cranks separated only by the length of the main bearing, is the most suitable one for balancing the weight of the moving parts as it makes the "arm" of the "rocking" couple as short as possible.

For the four-stage type the shortest arrangement of cylinders would be to have the high pressure and the low pressure forward, and the two intermediate aft. This will make the cranks of the high pressure and first intermediate at right angles, the first intermediate and second intermediate opposite; and of the second intermediate and low pressure at right angles. If it were desired to have the cranks of successive cylinders at right angles the arrangement could be high pressure cylinder forward, next the second intermediate, then the low pressure, the first intermediate pressure cylinder being aft. This would make the length over the cylinders rather more than with the previous arrangement, but would give greater facility than the other arrangement for making the weights of the two forward pistons equal and the weights of the two after pistons also equal.

As it is of importance that the initial loads be not increased by the pressure at release falling much below, or the initial pressure in the next cylinder rising much above, the mean back pressure, Figs. 10 and 11 have been prepared to show the variation in the exhaust line of the high pressure, first intermediate, second intermediate and also the variation in the admission pressure of the first intermediate, second intermediate and low pressure cylinders for cranks at right angles and cranks opposite. They also show the effect of different capacities of receiver space, the full lines representing the effect with receiver capacity equal to the cylinder, and the dotted lines the effect with receivers equal to twice the cylinder capacity.

The method of setting out is that described by Professor Unwin in "Elements of Machine Design," except that allowance has been made for the effect of the angularity of the connecting rods. It will be seen that, on the whole, the least increase of initial load is secured by the cranks at right angles, especially at the lower pressures. Hence the cranks of the second intermediate pressure and the low pressure should always be arranged at right angles; and if it is necessary to have any of the cranks opposite, they should be the high pressure and the first intermediate pressure, or the first intermediate pressure and the second intermediate pressure.

In conclusion, the writer would again emphasize the main point which he has attempted to bring out in the paper, viz., the importance of keeping down the cost of the new machinery. This means that a change to a cheaper type of boiler would be desirable, and that the design of the engines should be such as will give the minimum number of bearings and working parts.

REPORT UPON THE CONDITION OF ADMIRAL CERVERA'S VESSELS.*

AFTER AN EXAMINATION BY A BOARD OF UNITED STATES NAVAL OFFICERS.

Special Attention Given to the Effect of Our Gun Fire, of Combustible Material, and Explosions—Sketches Showing Number and Location of Hits—Conclusions Drawn by the Board.

TORPEDO-BOAT DESTROYERS PLUTON AND FUROR.

The Board visited the locality of the wrecked torpedo-boat destroyers Pluton and Furor on the morning of the 7th of July, 1898, and reports as follows:

Pluton—The Board finds that the torpedo-boat destroyer Pluton, after having been seriously damaged by the fire of our squadron, was wrecked upon the rocks about three miles west of the Morro, and that the wreck is now entirely submerged. The wreck lies slightly to the westward of Cabanas Cove. The only part remaining visible are some davits, which are awash in the surf.

The Pluton was on the rocks on the afternoon of the 3d inst., and on the morning of the 7th, when the Board passed her position, she was entirely submerged; the only thing visible about her being the davits awash in the surf, as above mentioned.

It is therefore impracticable to wreck the Pluton.

Furor—The Furor was sunk in deep water by the gun fire of our squadron. It is reported by the officers of the Gloucester that her structure, at the time she sank, was in fair condition.

The considerable depth of water, which is not accurately known, probably precludes the possibility of wrecking her.

Almirante Oquendo.

CONDITION OF HULL.

Condition of Flotation—The vessel lies uneasily, down by the stern, with slight heel to starboard, flooded throughout. The bow is about 3 feet light and the stern about 8 feet deep. The angle of heel aft is about 4 degrees, and forward about 7 degrees. No soundings were taken, for as seen below, the vessel is a structural wreck, and practically broken in two. Examination was limited to the above water portion.

STRUCTURAL SOLIDITY.

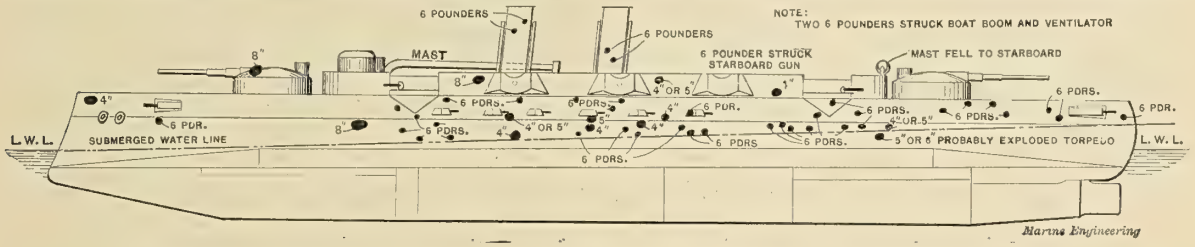
Frames—The magazine forward wrecked the frames on both sides above the protective deck. On the starboard side, the heels of frame were torn from the protective deck; the whole side being blown out for a distance of about 60 feet, extending aft from the transverse armor. The side in this region hangs about four feet beyond the outer edge of armor belt. On the port side the frames are blown away with the skin plating just above the protective deck for a distance of about 15 feet in length by 6 feet in width. Explosion on the after waist torpedoes carried away frames with the skin plating just above the protective deck for a distance of about 12 feet long by 4 feet wide.

Deck Beams—In wake of the forward magazine, explosion extending over a length of about 40 feet aft from the forward turret, the deck beams throughout are practically destroyed. The platform deck is seen upheaved to the protective deck on the port side. The protective deck beams are wrenched from their fastenings at the sides and are sheared along the seams of armor plate amidships and on port side; the deck opening up and being heaved up in the upper part to about the height of the gun deck. The gun deck beams and upper deck beams are

*Second and last installment of the complete report of the Board of Examination.

blown away, dislocated, and deformed in the region of the explosion. Over the torpedo explosion aft, the deck beams of the gun deck are similarly dislocated and deformed for a distance of about 15 feet. In addition to the above injuries by explosions, deck beams of the gun and main decks have been warped, dislocated, and in some cases dropped down from the effects of heat in a manner similar to that found on the other vessels.

Bulkheading—Below the protective deck is blown away in the region of the magazine explosion, as far aft as the boiler-room bulkhead. It is doubtless blown away, for some distance at least, on the forward side of magazine, where examination could not



ALMIRANTE OQUENDO—APPROXIMATE LOCATION OF HITS AND PROBABLE SIZE OF PROJECTILES.

extend. The bulkheading above the protective deck has been affected by heat in a manner similar to that on the other vessels previously described.

COVERINGS.

Outside Plating—The outside plating is broken vertically on both sides, from the height of the protective deck to within a short distance of top of bulwarks about abreast the forward turret just forward of the transverse armor, the cracks generally following a zigzag course along rivet lines. A similar crack starts on the port side at the armor shelf, about awash at this point, about 30 feet farther aft, and extending downward beyond the limit of visibility. On the starboard side, from the transverse armor to the boiler-room bulkhead, the plating with frames are wrenched from their fastenings at the upper edge of the armor, and hang about four feet beyond the side of armor belt. On the port side a plate is blown entirely off at a short distance above the protective deck, and the joint with the armor belt is broken off for about 40 feet; the side plating being about one foot and one-half inside of the armor belt. Aft, abreast the torpedo explosions, a plate is blown off on each side.

Deck Plating—In the region of the magazine explosion forward, the platform deck is completely wrecked; in parts it is blown up against the protective deck. The protective deck is also completely wrecked, being torn from the sides and opened up along the two armor seams; shearing the beams and being heaved up 5 to 10 feet. The gun deck and upper deck have been affected by heat more or less as in the other vessels previously described. Thus the vessel is practically broken asunder in the region of the forward turret, and, without taking into account other structural injuries, it is evident that it would be impossible to raise and save her. Moreover, in view of the uneasy condition of flotation, she is liable to break in two under even a moderate stress of sea and it therefore is advisable to begin the operation of stripping her at the earliest moment practicable.

EFFECT OF EXPLOSIONS.

Torpedo Explosions—Conditions—The region of the explosions is flooded and more than a partial examination was impracticable. Effects—Generally speaking, the injurious effect was limited to knocking off completely one plate of shell plating and dislocating or distorting three or four of the gun deck beams. As far as can be seen, the protective deck is uninjured. It is to be noted here, as on the torpedo explosion on the Vizcaya, that at a very moderate distance, not greater than three feet, the protective deck successfully withstood the shock.

Magazine Explosions—Conditions—The quantity of explosives, and the exact location of the explosions could not be determined. From the effects

OFFICIAL PHOTOGRAPH OF THE WRECK OF THE TORPEDO BOAT DESTROYER PLUTON.

produced, however, it would seem that the main forward magazine exploded; the location being practically the same as on the Vizcaya. Effects—The general effects are similar to those of the forward magazine explosion on the Vizcaya, though they indicate a more violent explosion. The structural weakness at the juncture of the forward and the midship portion of the vessel, arising from the discontinuity of the protective deck, is brought out more strongly; the explosion, combined probably with some effect of uneasy grounding causing the vessel to break in this region. It showed a weakness of juncture of upper works and protective deck, and protective deck with belt armor; a fact less markly shown in the case of the Vizcaya. Similar cutting away of bulkheads below the protective deck is seen, and in addition the platform deck is visibly upheaved toward the protective deck. Similar stiffening effect of structures above the protective deck is shown in the case of coal-bunkers, conning tower, turret, etc., giving the same wavy appearance.

CONDITION OF ORDNANCE EQUIPMENTS, ETC.

The after 11-inch gun and mount is in excellent condition. At the forward 11-inch gun a shell struck and exploded between the gun and the turret shield. This shell probably killed the men found dead in this turret. It jammed the turret, broke the plate forming the left side of the gun port in the shield, where it struck, cut the pipes and connections in the turret, and completely disabled it. The gun and the heavy parts of the mounts seems to be uninjured. Both 11-inch gun mounts require such work as will correct the injurious effect of the elements; and in the forward turret the piping needs renewal in order to make the turret serviceable.

The 5.5-inch (14 cm.) battery is burned, but not to such an extent but that it can be rendered serviceable by cleaning, overhauling and repairing. Several of the 5.5 (14 cm.) guns will need the new breech blocks. The after 5.5 (14 cm.) gun on the starboard is dismounted. It lies with its trunnions on the slides of the lower carriage, the cnase resting in the bottom of the gun port of the shield. Neither the gun nor carriage seems to be damaged, and it is quite possible that this gun was thus dismounted by the mainmast falling upon it. The mainmast now lies across the chase of the gun. New cap squares seem to be the only repair necessary for this gun.

The next gun forward, on the starboard side, has the mark of a 6-pounder shell in it just forward of the trunnions. The shell penetrated to the depth of 1½ to 2 inches. This will probably render the gun dangerous for service use.

The shield of the third gun on the port side has a 5-inch hole through it; minor portions of the mount are also damaged.

The secondary battery on the lower dack is very badly burned. While it can be saved, and possibly be made serviceable again, it is questionable whether it is desirable to do so.

The torpedo outfit is so badly damaged by shot and fire as to be ruined. At the port after broadside torpedo tube a violent explosion has occurred, probably that of one or more of the torpedoes located in that compartment. This explosion wrecked the torpedo compartment, the torpedo tubes, and the torpedoes stowed in the racks on both sides of the compartment.

The magazines are all under water and could not be examined; but the forward magazine has evidently exploded, forcing the protective deck up several feet, detaching it from its fastenings to the side, and blowing out both sides of the ship, especially on the starboard side. The after magazine, apparently, did not explode.

CONDITION OF MACHINERY AND BOILERS.

There is no evidence of the engines being damaged, nor any of the boilers having exploded. Water covers all the machinery, so that a close examination cannot be made. All pipings and auxiliaries above the protective deck are destroyed or damaged irreparably.

EFFECT OF GUN FIRE.

The effect of gun fire upon this ship was terrific. The sides, smokestacks, ventilators, hatch trunks, all seem to have been riddled by shell, by fragments of shell and by an infinite number of small projectiles. When it is considered that boats which no longer exist were in place and must have been frequently hit, it will be recognized that the effect of this fire was quite sufficient to create dismay among the ship's company besides setting fire to the woodwork.

It has been reported by one of the Oquendo's crew that a torpedo was struck by a projectile, which caused it to explode, killing a great number of men. This report is probably correct, as the effects of two such torpedo explosions are found on board the Oquendo, one at the after broadside tube on the port side and the other in the forward broadside torpedo room. A shell pierced the side of the after broadside torpedo room within a few feet of the torpedo tube, and may have exploded the torpedo head. The board could not substantiate the report by the evidence available. The forward torpedoes were doubtless exploded by the heat of the flames in that vicinity.

The intense flames to which the three ships were subjected, and the serious explosions of magazines and torpedo heads, caused by the heat of the flames, have so completely consumed all articles and material of inflammable nature that it has been impossible to describe more definitely and in detail the effect of the gun-fires.

Three 8-inch, one of them an armor-piercing shell, passed completely through the ship, striking in the superstructure and passing through the drum-rooms and bulkheads and out under starboard sea ladder at the water-line.

One 8-inch common shell struck the hood of the forward 11-inch gun, at the edge of the port, detaching one of the port lanyards, bursting, and evidently killing every one in the turret and disabling the gun.

The approximate location, direction and the size of the shell which struck the Oquendo are given in detail as follows:

Commencing forward on the port side:

One 4-inch shell went in on the gun-deck, ranged from aft forward near the moulding of the bow.

One 6-pounder entered just under the forward 6-pounder sponson, under the gun deck, and ranged from aft forward.

One 8-inch common shell struck the hood of the forward 11-inch gun at the edge of the port, bursting, and killing the gun's crew, as noted above.

An 8-inch shell also struck under the gun deck, directly below the conning tower, ranging forward and across the deck.

One 6-pounder entered the gun deck, under the forward part of the sponson for the forward 5.5-inch gun.

Another 6-pounder entered directly under the point of the sponson on the gun deck.

A third 6-pounder shell struck under the after edge of the same sponson. All ranged from aft forward.

On the berth deck, directly under the forward and after parts of the same sponson, are holes showing the entrance of four 6-pounder shells, each ranging forward and across the deck, so that, underneath this one sponson, there are seven 6-pounder holes and one 8-inch hole, showing the terrible effect and concentration of our gun fire at this point.

One 8-inch common shell passed through the superstructure and across the deck in front of the forward smokestack.

Near the top of the forward smokestack are also two 6-pounder holes, one ranging forward and the other ranging aft.

Directly under the forward smokestack, on the gun deck, are two holes, one from a 6-pounder, ranging forward; and just below it a 4-inch or 5-inch shell hole, also ranging forward.

One the berth deck, at the same point, is a hole from a 4-inch, ranging forward and across the deck.

About the middle of the after smokestack are two holes from 6-pounders, ranging forward.

Two 6-pounder shells also struck the boat boom on the mainmast, and the ventilator just forward.

Just under the after smokestack, on the gun deck, are the holes of five 6-pounders, all ranging forward and across the deck.

Also down on the berth deck, at the same point, two 4-inch shells entered, ranging forward and across the deck; and just beneath them two 6-pounders.

In the superstructure, just abaft and after smokestack, a 4- or 5-inch shell struck and ranged foward.

A 6-pounder shell passed across the deck at this same point, and struck the gun on the starboard side.

On the gun deck, under the sponson for the second gun from aft, are the holes of one 4-inch and two 6-pounders; and on the berth deck, just under the same point, are the holes of three 6-pounders, all ranging forward.

Just forward of the after sponson, in the superstructure, a 4-inch shell passed through from aft forward.

Under the after sponson three 6-pounder shells passed in the gun deck, from aft forward.

On the berth deck at the same point are six 6-pounder holes, all ranging forward.

Just beneath the forward part of the after barbette is the

hole of a 4-inch or 5-inch shell, ranging from aft forward and across the deck.

On the gun deck, between the after part of the after barbette and the sponson for the after 6-pounder gun, are the holes of five 6-pounder shells, ranging from aft forward and across the deck.

Just abaft the sponson for the 6-pounder on the gun deck is another 6-pounder hole, ranging forward.

As the vessel had settled so that the main deck was not more than six feet out of the water quite a large area of the hull could not be inspected. The armor belt was not struck or pierced as far as could be observed.

Three 6-pounder armor-piercing shell pierced the hull on the starboard side; the general direction of these was from aft.

CONCLUSIONS.

The Oquendo was beached in a small cove about one-half of a mile to the westward of the Infanta Maria Teresa. It would be most difficult, if not impossible, to save this vessel. She is structurally wrecked, and is practically broken in two at a point about abreast the forward turret, besides being more or less severely injured elsewhere. The Board finds, for the above reason, that it is impracticable to wreck the Almirante Oquendo; and is further of the opinion that with the proper wrecking facilities, the battery of 5.5 (14 cm.) and the turret guns may be saved to advantage.

Vizcaya.

CONDITION OF HULL.

Condition of Flotation—The vessel is nearly upright, and lies in a position corresponding nearly to the L. W. L. Flooding of the hull is nearly complete fore and aft. The vessel rests easily, but as the structural solidity does not warrant the effort to save the vessel, as pointed out below, diving and complete soundings were not undertaken.

STRUCTURAL SOLIDITY.

The examination extended inside that portion of the hull now above water, corresponding to the position above the protective deck, as well as to the portion immediately below the protective deck in the vicinity of the magazine explosion. Frame—Above water, the frames are cut forward on the starboard side for a distance of about 12 feet abreast the torpedo manipulating room, in wake of the torpedo explosions.

The frames are torn from their fastenings to the protective deck on the starboard side in wake of the forward magazine explosion, along a space extending from abreast the forward turret aft for a distance of about 40 feet.

Deck Beams—The deck beams of the berth and gun decks forward, in the vicinity of the torpedo manipulating rooms, are broken for a distance of about 20 feet. The beams of the protective deck are sheared along the armor seam on the starboard side in wake of the forward magazine explosion, for a distance of about 30 feet, along a space extending aft from the transverse armor abreast of turret. The beams of this deck are sheared on two sides, along the armor seams, above the after magazine explosion, the effects of which extend from the after transverse armor almost abreast the turret forward to the glacis over engines. The beams of the gun deck are practically destroyed by distortion and dislocation for a distance of about 30 feet, above each magazine explosion. Those of the upper deck are similarly injured, though over a less extent and in a less aggravated manner. The heat effects of warping and distortion and the sinking beneath local weights extend generally to the upper and gun decks, being more pronounced where there is no metal plating. For the decks below water, although examination could not be made, the effects on the beams are doubtless more pronounced than those above the protective deck.

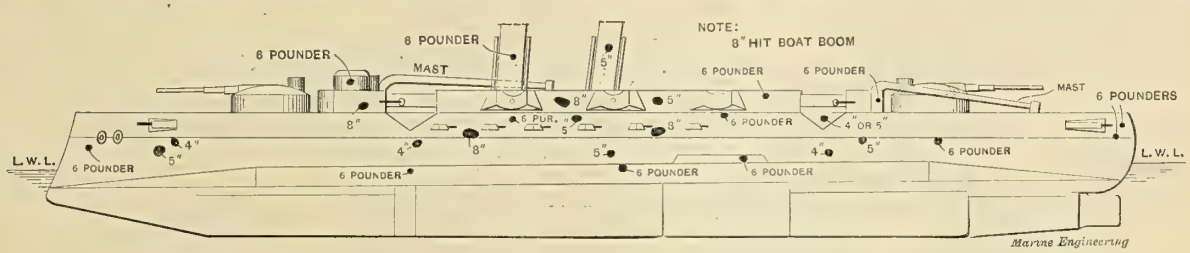
Bulkheads—Above water the bulkheading has been affected by heat in a manner more or less similar to that described for Infanta Marie Teresa. Below water, forward, the bulkheading is cut away from the transverse armor forward as far aft as could be seen; this injury extends to the boiler and engine spaces.

Coverings—Outside Plating—The outside plating is blown off forward on both sides in wake of the torpedo manipulating room for a longitudinal distance of about 20 feet. This injury extends from the protective deck at the sides in wake of the forward magazine explosion from the transverse armor aft for a distance of about 40 feet.

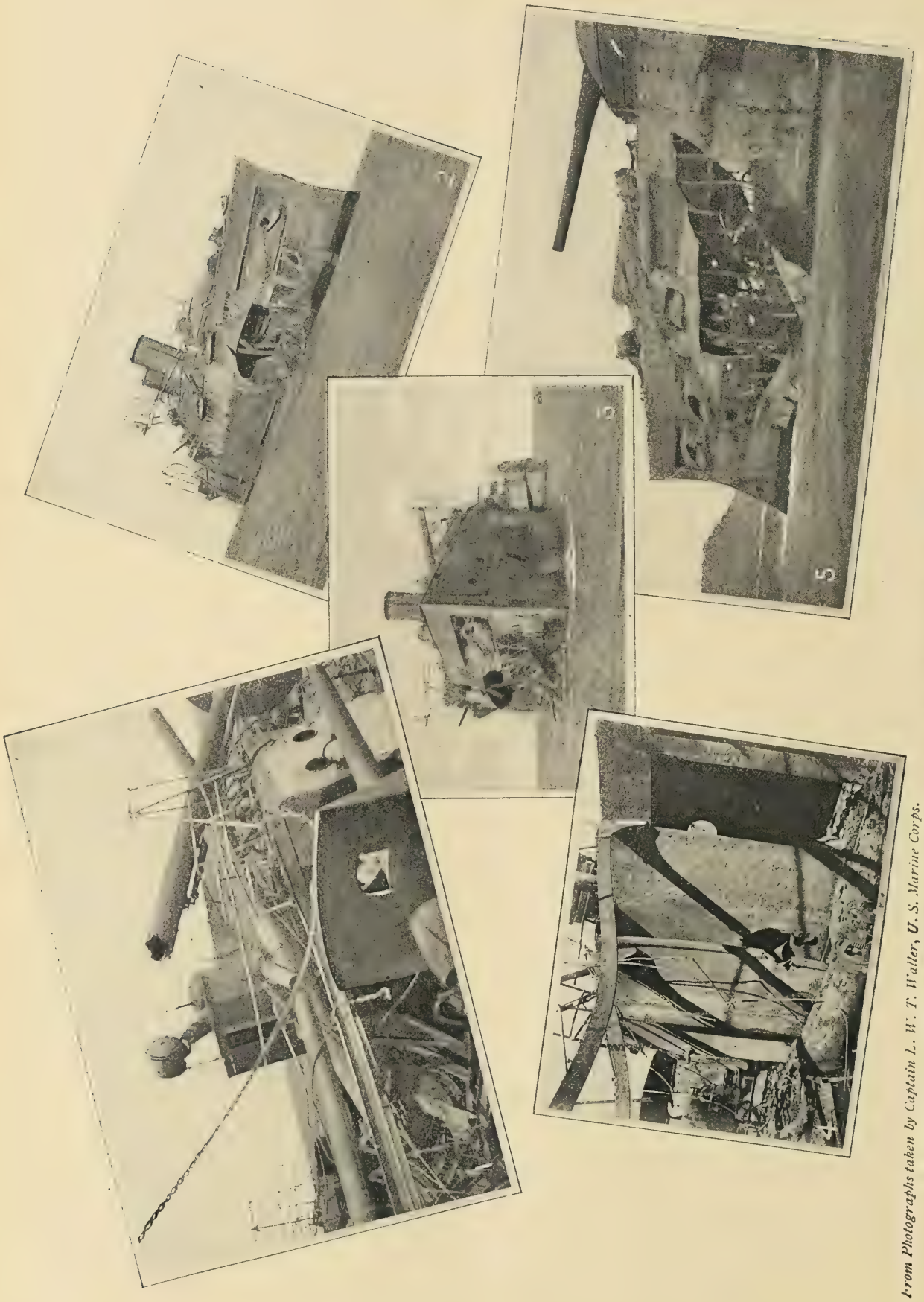
Deck Plating—The heat effect on stringers, tie plates and other plating of the gun deck and upper deck are more or less similar to these described for the Infanta Maria Teresa. Forward in the region of the torpedo explosion the plating of the berth and the gun deck is practically destroyed, being driven down in case of the berth deck. In the case of the gun deck, after being blown through, the deck fell down upon the berth deck, the deck beams and stanchions having been carried away. The gun deck carried also the weight of the windlass, which fell with the deck. Plating of the upper deck in the same region is blown through upward and folding back for a length of about 15 feet. Thus the explosion forward carried away the upper half of the longitudinal girder structure, and the longitudinal connections at the juncture of the transverse armor would, in all probability, break off. The magazine explosions carried away the larger part of the transverse stiffening members amidships, corresponding to the webb and upper flange of the transverse girders. This occurs in the part where the beam is the greatest, and the side weights heaviest. When parallel to the waves in a sea way, even if not in still water, the sides would settle and entail the vessel's destruction. Thus the internal explosions have destroyed the vessel's structural solidity, both as a longitudinal and transverse girder, and it would be inadvisable to attempt to raise the vessel.

Internal Explosions—As seen above, this vessel furnishes examples of both forms of usual explosions.

Torpedo Explosions—The fragments of four torpedoes originally stowed in racks were found forward. The tubes remained lodged in their ports unbroken, the location of the explosion being about 10 feet abaft them. The size of the torpedo tube is fifteen inches. The torpedoes were stowed close

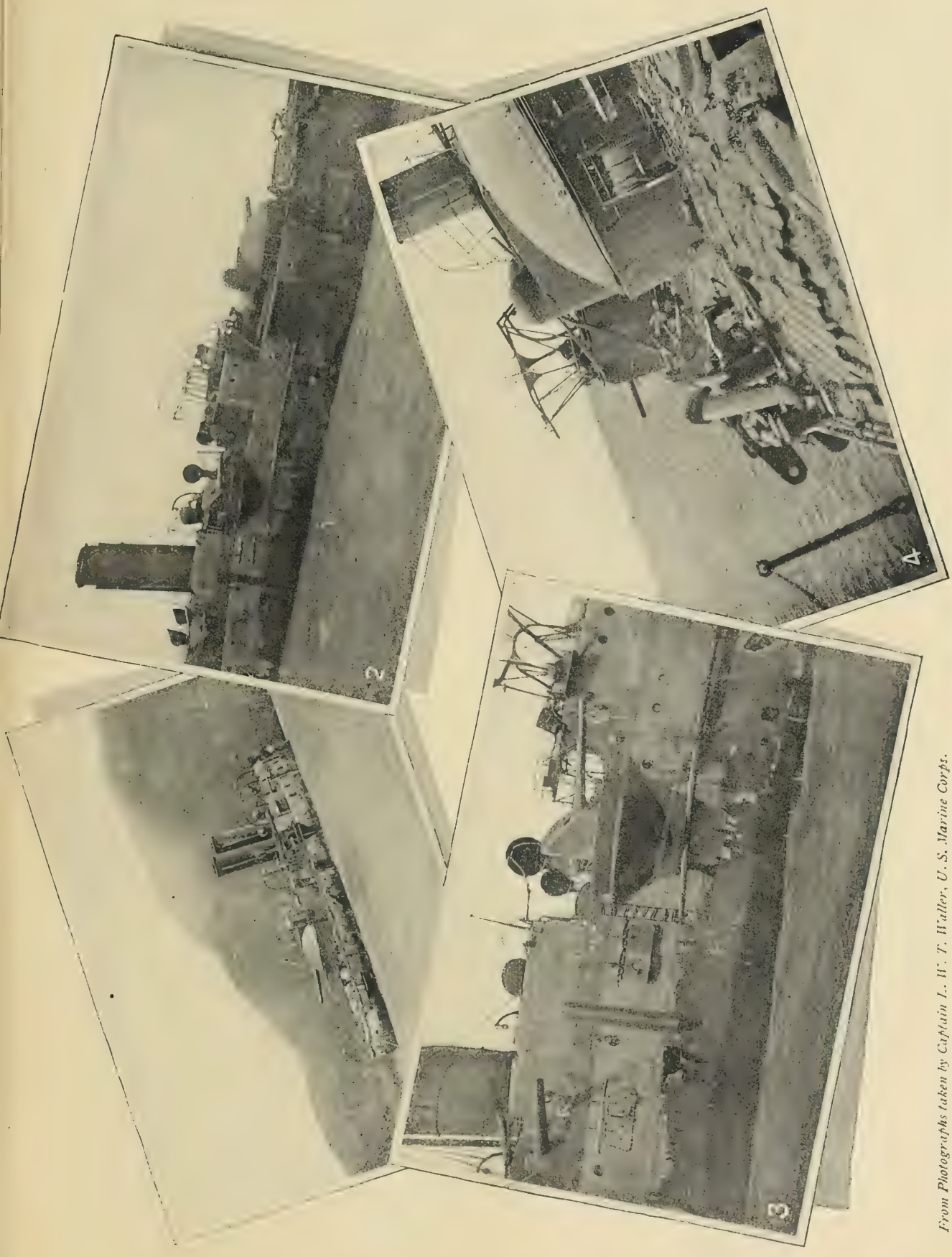


VIZCAYA—APPROXIMATE LOCATION OF HITS AND PROBABLE SIZE OF PROJECTILES.



From Photographs taken by Captain L. W. T. Waller, U. S. Marine Corps.

U. S. OFFICIAL VIEWS OF THE WRECK OF THE VIZCAYA—REPRODUCED BY PERMISSION—FOR DESCRIPTIONS SEE PAGE 20.



From Photographs taken by Captain L. W. T. Walker, U. S. Marine Corps.

U. S. OFFICIAL VIEWS OF THE WRECK OF THE ALMIRANTE OQUENDO—REPRODUCED BY PERMISSION—FOR DESCRIPTIONS SEE PAGE 20.

to the sides, about about two and one-half feet above the berth deck. The cause of the explosion of the torpedoes was due to the heat of the flames in the vicinity.

Effects—As far as could be seen no damage whatever was done to the protective dock on either side. The berth deck was wrecked completely in the immediate vicinity, but over a comparatively small area; rather singularly a bulkhead below held a small part of the deck up in place, the downward thrust crushing, straddling, as it were, this bulkhead. The effect on the side plating on the gun and upper decks are given below. It is to be noted in this explosion of gun cotton that, though everything in the immediate vicinity was wrecked except a plate on end (the bulkhead below), yet at a moderate distance the armored protective deck gave effectual resistance, and beyond the gun deck the effect was more or less that of a lower order of explosion.

MAGAZINE EXPLOSIONS.

Conditions—Explosions occurred in both main magazines. The quantity of explosive and the exact location of the explosions could not be determined.

Effects—In both cases the protective deck in the region was blown open along an armor seam on each side; the plating in each case shearing the deck beams along the seam. The opening was greatest on the starboard side forward; there the armor plates were raised about five feet, making a wide breach through which the pressure relieved itself. The dislocation of the deck tore away the fastenings to the vertical armor, transverse and side, and tore away the heels of the frames above the protective deck, opening the ship's side along the joint of the protective deck. On the port side, forward, the upheaval and opening of the deck were small. After passing through the protective deck the effect of gases in all cases was small, as the pressure was practically relieved owing to the covering on the gun and spar deck having been burnt away. Below the protective deck the gases on the starboard side cut away bulkheads as far aft as the boiler-rooms, and seem to have partially cut bulkheads still farther aft. There was no execution on the sloping protective deck forward; the transverse armor having interposed an effective limit, but there is every reason to believe that below this deck the cutting away of bulkheads propagated itself forward as well as aft. The opening on the port side disclosed, beneath, a bulkhead folded *forward* by a rush of gas from aft.

In the explosion aft, the protective deck was raised amidships; shearing the beams on both sides at the seam of armor plates, well out toward the sides. The middle portion was raised about a foot along a distance extending from the transverse armor to the glacis over engine, the after glacis plate being dislocated.

Beneath the deck the same cutting away of bulkheads took place as was found forward. This extended as far forward as could be seen to about the forward bulkhead of the engine room. The openings in the deck have limited area and could give but partial relief to the gases which it would seem advanced forward and aft carrying down bulkheads as they went, till on the port side they reached the forward magazine. The protective deck by its strong resistance prevented the relief of pressure upward and in the progressive explosion the gases relieved themselves by propagation fore and aft below the deck, breaking down the less resisting bulkhead obstruction.

In the case of both magazine explosions the protective deck presents a more or less extended wave from being held down in place where weight and stiffeners existed as under conning tower, turrets, upper coal bunkers, etc., and being raised in proportions without upward stiffening.

CONDITION OF MACHINERY AND BOILERS.

The water covers the engines up to within 18 inches of the tops of the cylinders. So far as can be determined, the boilers and engines are intact, or, at least, not irreparably damaged.

The lagging is burnt off. There may be damage due to the fire having cracked castings; but this cannot now be ascertained.

Judging from appearances the fire was under way some time before the water rose in the engine compartment.

The same remarks concerning the boilers and piping above the protective deck can be made as in the case of the Infanta Maria Teresa.

EFFECT OF GUN FIRE.

The following was the effect of the gun fire of our squadron upon the Vizcaya, as noted by careful inspection:

Beginning aft, on the port side, there are:

Two holes made by 6-pounders passing through the sides into the berth deck, ranging from aft forward.

One 6-pounder shell made a clean hole through the ship's side into the berth deck, just abreast the after turret.

One 5-inch entered a little over and abaft the after broadside torpedo tube. It passed on to the berth deck, ranging forward, and carried the torpedo tube away from its fastenings.

One 4-inch shell entered the berth deck under the after edge of the after 14 cm. gun sponson, and ranged through to the other side.

One 6-pounder went through the superstructure just forward of the after 5.5 (14 cm.) gun.

One 6-pounder went in on gun deck under the second 5.5 inch (14 cm.) gun from aft, and did not explode.

One 8-inch shell struck on the gun deck just abaft the after smokestack, ranged aft and across the deck.

One 5-inch shell entered the berth deck abreast the after smokestack, ranging from aft across the deck.

One 8-inch shell went through the superstructure sideways, midway between No. 2 and No. 3 14 cm. gun. It ranged across the deck.

One 6-pounder entered the gun deck under No. 2 5.5 (14 cm.) gun.

One 8-inch shell entered on the gun deck between Nos. 1 and 2 5.5-inch gun and ranged forward across the deck.

One 4-inch entered on the berth deck just under the sponson for the forward 5.5-inch gun, ranged forward and across the deck.

One 6-pounder struck a slanting blow from forward aft on the upper edge of the armor belt about four inches from the top and abreast the after smokestack. It penetrated about an inch.

Another 6-pounder glanced off under the sponson of the forward 5.5-inch gun.

One 8-inch shell struck the superstructure just under the bridge, went through the men's head and then burst, scattering fragments about the decks. It ranged from aft forward. Some of the fragments struck the forward barbette.

One 5-inch and one 4-inch struck under the bill board of the port sheet anchor, passing in on the gun deck. One ranged forward, and the other across the deck.

One 6-pounder passed through the forward smokestack, one-third up from the deck.

One 5-inch passed through the after smokestack, near the top. Both shots were apparently fired from the quarter.

Descriptions of the Official Photographs of Spanish Warships Wrecked and Sunk at Santiago, in the Naval Engagement July 3, 1898, Reproduced on Pages 18 and 19.

VIZCAYA.

1. Showing destruction of main mast and shot holes in boat boom.
2. Showing effects of internal explosion of torpedo.
3. Bows on.
4. Showing where 8 in. shot passed through port head.
5. Port bow, showing rent caused by explosion.

ALMIRANTE OQUENDO.

1. View of ship from starboard quarter.
2. Broadside opposite starboard bow.
3. Starboard side, showing exit of large shell.
4. Shows sinking of turret after magazine explosion.

The derrick-boom of the mainmast is bent in two, about nine feet from the goose neck, by an 8-inch shell.

One 4-inch or 5-inch passed through the sponson of the after 5.5-inch (14 cm.), just under the gun.

One 6-pounder entered the superstructure from directly astern, and ranged forward.

One 4-inch and one 5-inch penetrated the deck from aft directly under the bill board.

One 6-pounder entered the gun deck forward of the hawse pipe, ranging forward.

The forward compartment of the ship was destroyed by an explosion of the torpedoes stowed there. The explosion was undoubtedly due to the heat of the fire at that place.

The sides are blown out, the supports are blown away, so that the capstan, anchor chains, bitts, etc., fell down to the deck below. The beams of the gun deck and the spar deck are carried away on the starboard side, and the spar deck plating of the starboard side is turned up into the air. The racks for holding the bow torpedoes were found in the forward compartment, and parts of the exploded torpedoes were also found.

It is evident that the fire of the guns' crews of the Vizcaya was very materially lessened and almost silenced by their not being able to serve their guns under the severe fire poured upon them by our ships.

The fact that no wood work is found remaining on board the Vizcaya—except that which is still smoldering about the scroll work of the bow—is evidence of the effect of the shell fire upon a ship in which any considerable amount of wood work is employed.

From observation, the fire seems to have started well aft in the ship, whence it spread very rapidly to the rest of the ship.

The after magazine blew up about 12.30, not long after this vessel was beached. The explosion destroyed the protective deck, and, in places, raised it considerably out of position.

The evidence of the effects of the explosion of *many* of our shells is lacking, although it is probable that pieces of exploded shell may have struck parts since consumed or destroyed by fire. There is evidence, however, that two large shell—8-inch—exploded. The effects of this explosion must have been very disastrous to men in that vicinity.

One 6-pounder and one 5-inch shell went through the ship from side to side.

As a precaution, in case the torpedo tubes should be struck, they were all fished with grate bars and chains in the wake of the war heads.

The number of shells that struck the ship seemed to show by their direction that about one-half struck as she was leaving the harbor, the shell ranging aft, and the other half as she was attempting to run away.

CONCLUSION.

The Vizcaya was grounded and now lies almost directly in the fairway of the channel leading to Accerederos about eight miles west of the Morro of Santiago de Cuba.

The Board considers that the vessel has no structural strength either in a longitudinal or transverse direction sufficient to warrant the endeavor to wreck her.

The girder weakness is due principally to the cutting away of the internal structure, although the shell plating is more or less intact.

This cutting away of the internal structure extends to practically all the transverse connections lying between the forward and after diagonal armor. The bulkheads and deck beams throughout this entire space have been practically destroyed by internal explosions.

The fastenings of the armor deck with the ship's side have been practically torn apart, and no longer exists. There is no plating on the upper deck, nor deck stringers that are of any consequence.

The Board is, therefore, of the opinion that it is inadvisable to attempt to save the Vizcaya.

The Board recommends that the ship should be secured at once with anchors and cables, so as not to be moved from her present position until she has been stripped.

Secretary of the Navy John D. Long has written an important letter, under date of October 14, in response to an inquiry made by volunteer officers of the Navy as to the probability of their being permitted to remain permanently in the service. His reply is in the main unfavorable, and he evidently looks for a solution of the difficulty of having an insufficient number of officers in the Navy, in the passage of the Personnel Bill.

DEPARTMENT PLANS FOR TORPEDO BOATS AND DESTROYERS FOR THE U. S. NAVY, RECENTLY CONTRACTED FOR.

Bids were opened at noon on August 23, 1898, for the construction of twelve torpedo-boats and sixteen torpedo-boat destroyers, the total cost of all, exclusive of armament, being limited by the appropriation bill to $6,900,000, and with a proviso that not more than four torpedo-boats, nor more than five destroyers, should be built in any one yard, or by any one contracting party.

The Department invited bids under two classes, viz.: The first, for the construction of hull, machinery, and their appurtenances complete in accordance with the plans and specifications provided by the Secretary of the Navy, and the installation of ordnance and outfit; the second, for the construction of hull, machinery and appurtenances complete on plans and specifications submitted by the bidder, and the installation of ordnance and outfit in accordance with the requirements of the Department.

In the circular calling for bids, certain essential elements of design were stipulated in order to place intending bidders, under class 2, on the same footing, and also to obtain vessels having similar characteristics as nearly as practicable. For the torpedo-boats these were:

1. Displacement between 150 and 170 tons.
2. Vertical propelling engines in separate water-tight compartments, each with a condenser, driving twin screws.
3. Water tubular boilers, and a coal bunker capacity of at least 40 tons.
4. Berthing space for a crew of 26 men and 3 officers, and provision space for 20 days.
5. Guaranteed speed of at least 26 knots.
6. On an official trial of two hours, vessels to average the guaranteed speed with every part of hull and machinery complete, including spare parts and fresh water necessary; and in addition, to carry ordnance weighing 9 tons; coal, 10 tons; crew, stores and equipment of 8 tons.

Free scope was allowed in working out the design provided the above requirements were met, and the average cost of each vessel did not exceed $170,000. All bids had to be accompanied by complete plans and specifications for building, and such calculations of weights, displacement and stability as would demonstrate the strength and seaworthiness of the vessels. In considering bids so submitted, the Department obligated itself to give due preference to those designs, all other things being equal, which indicated the best sea-going qualities; gave the best protection to engines and boilers; guaranteed the highest speed; best suited, in general characteristics, to the naval service; and, finally, the shortest time in which bidders would guarantee completion.

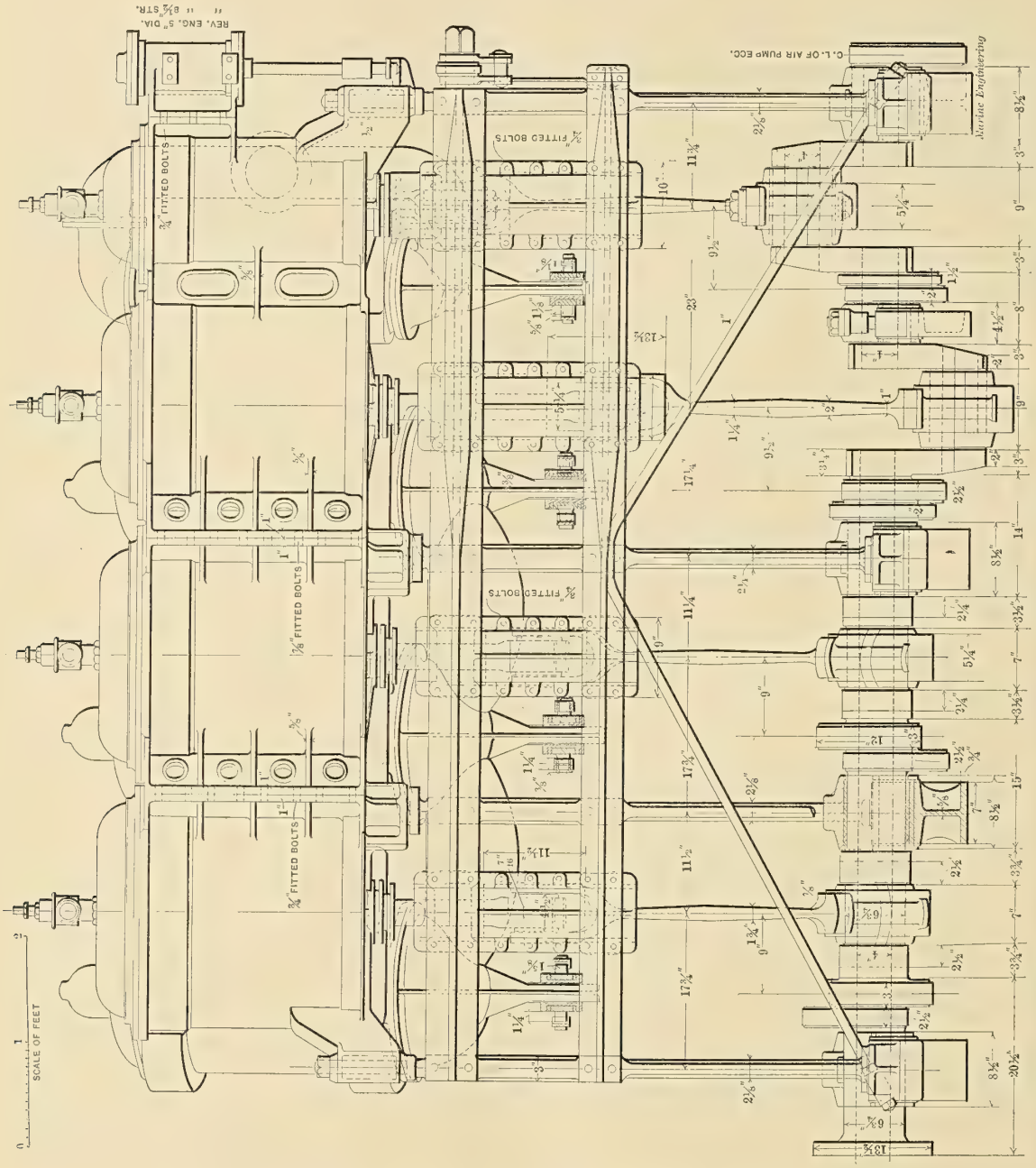
While the Government reserved the right to reject any and all bids not considered advantageous, no bid was to be considered which proposed a speed of less than 26 knots. On the trial, however, if the average for the two hours

fell below the figure guaranteed by the contractor, the vessel might be accepted at a reduction at the rate of $3,000 for each quarter of a knot, with the provision that a speed below 25 knots would subject the vessel to rejection.

The maximum time for completion under any circumstances was limited to twelve months, with penalty for over time as follows: $30 per day for the first month succeeding the period fixed; $60 a day for the next month, and $100 per day thereafter.

In plans of the destroyers, submitted by bidders, the average cost was limited to $295,000, due preference being given for desirable characteristics, as mentioned for the torpedo-boats, with restricting elements of design as follows:

1. Displacement between 400 and 435 tons.
2. Vertical propelling engines in separate water-tight compartments, each with a condenser, driving twin screws.
3. Water tubular boilers, and a coal bunker capacity of at least 100 tons.
4. Berthing space for a crew of 60 men and 4 officers, and provision space for 20 days.
5. Guaranteed speed of at least 28 knots.
6. On an official trial, of two hours, vessels to average the guaranteed speed with every part of hull and machinery complete, including spare parts and necessary fresh water; and in addition, to carry ordnance weighing 15 tons; coal, 25 tons; crew, stores and equipment of 12 tons.



REAR ELEVATION OF FOUR-CYLINDER TRIPLE-EXPANSION ENGINE FOR U. S. TORPEDO BOATS—BUREAU OF STEAM ENGINEERING DESIGNS—STARBOARD ENGINE.

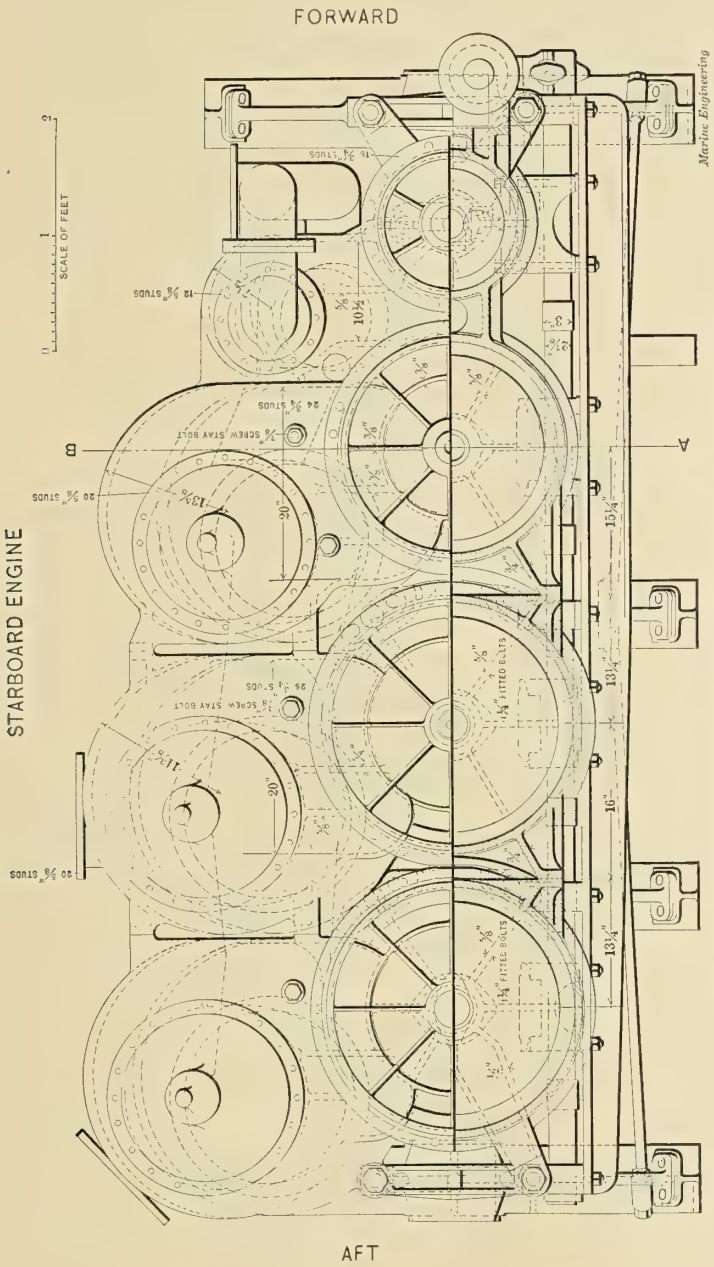
The maximum time allowed for completion was given as eighteen months, with a penalty, after specified time, of $50 per day for the first month; $100 per day for the second month, and $150 thereafter until delivery.

If on the official trial the average speed fell below 28 knots, the vessel was to be rejected; and for every 1-4 knot below the speed guaranteed by the contractor, a reduction of $8,000 was to be made. No premium was offered for excess of speed over that guaranteed. A summary of the essential features of the Department's design of both classes of vessels is given in the following:

TORPEDO-BOATS.

The torpedo-boats—designated from No. 24 (Bagley) to No. 35 (Wilkes)—are of about 7-feet draft, and have the following principal dimensions:

Length on load water line.....175 feet.
Breadth " " " .....17 feet.
Displacement (normal draft) about....165 tons.



PLAN OF TRIPLE-EXPANSION ENGINE FOR U. S. TORPEDO BOATS.

The outside plating is lap-jointed, and generally of 7 lbs. per sq. ft. (7-41 in. thick) for one-half of the length, being reduced to 6 and 5 lbs. respectively towards the stern and bow. Plates of the flat keel are of 10 lbs. for a length of 100 ft. amidships, reduced to 7 1-2 lbs. forward and aft. The vertical keel consists of 15-lb. plates of an average depth of 8 in.

Transverse frames and deck beams are bulb angle bars spaced 18 in., from center to center, throughout the length of the vessel, except in the engine spaces, where frames are disposed to accommodate the main bearings of the engines. For about two-thirds of the length amidships the frames and beams are 2 1-2 by 1 1-2 by 2 2-3 lbs. per lineal ft., reduced at the bow and stern to 2 1-8 by 1 5-16 by 2.2 lbs.

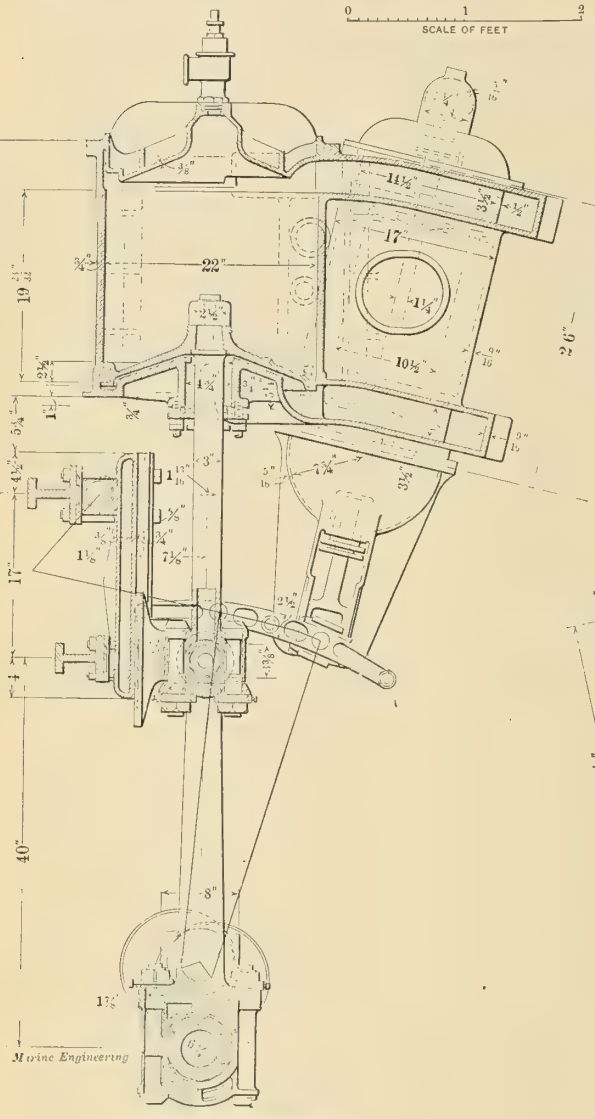
The floors are generally 12 in. at the widest part, lightened by holes where practicable, and extending continuously across the vessel from bilge to bilge, with reverse bars 1 1-4 by 1 1-4 by 1 1-4 lb. per ft. worked on their upper edges. Plates for this purpose are 10 lb. under the engines, boilers and thrust seatings; and elsewhere, throughout engine and boiler spaces, 8 lbs., reduced to 6 lbs. at the ends of the vessel.

Deck plates are generally of 4 lbs. per sq. ft., with a stringer of 6-lb. plate worked on the ends of the beams at either side.

The outside plating, frames, floors, etc., under water, and to 1 ft. above the normal water line, are galvanized by the hot process.

The engines are of the triple-expansion, vertical, direct-acting type, placed in separate water-tight compartments, driving twin screws, the designed horse power being 3,000 for both engines when making about 350 revolutions per minute. Their design is clearly shown in the accompanying scale drawings. Each engine has a high-pressure cylinder of 14 in. dia., one intermediate cylinder 22 in. dia., and two low-pres-

sure cylinders of 25 1-4 in. dia., all having a common stroke of 18 in.

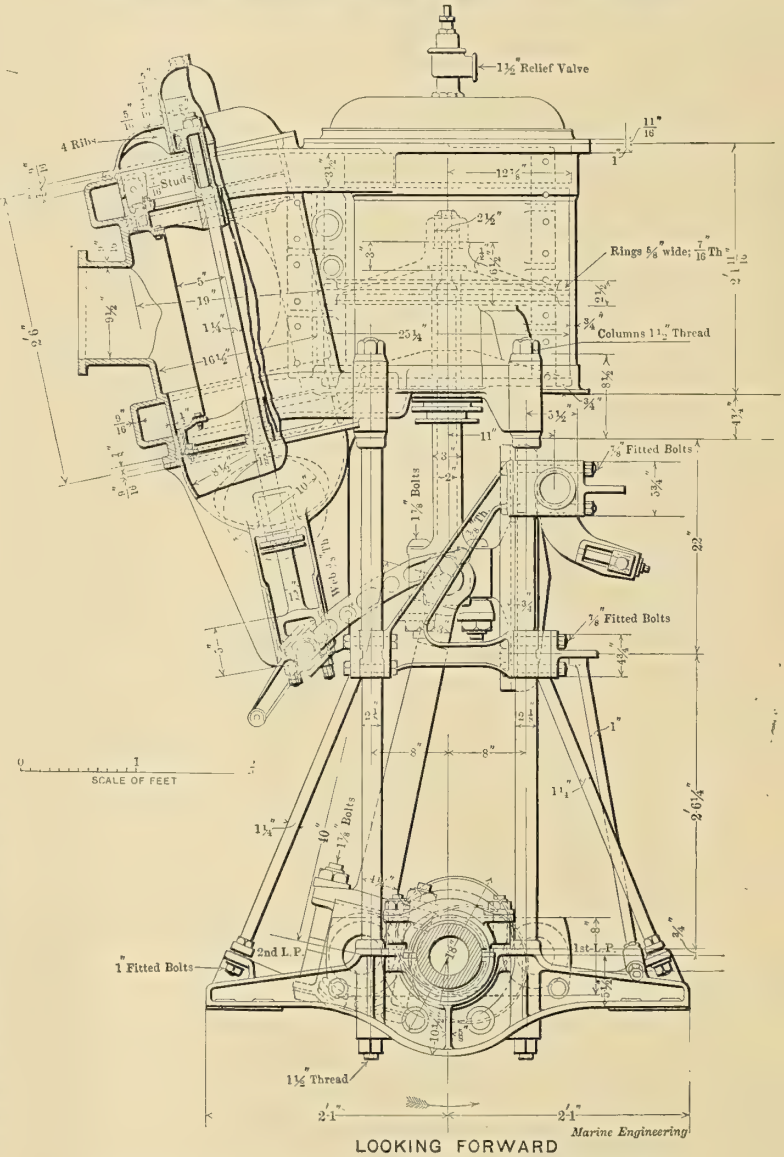


SECTION A-B—SEE PLAN

U. S. TORPEDO BOAT ENGINE.

To economize space in a fore and aft direction, the valves, which are all of the piston type—one for each cylinder—are placed on the sides and inclined to the cylinders. This arrangement is novel and admits of the use of eccentrics and Stephenson link motion for working the valves. The diameters of the latter are, respectively, 7 1-2 in., 14 1-2 in., 16 1-2 in., and only the two low-pressure valves are provided with packing rings, those for the intermediate and high pressure being turned and polished with emery to fit the valve liners accurately. It will be observed from the drawings that the center lines of all valve chests are parallel, but at varying distances from the fore and aft center line of the cylinders. Two main condensers, one for each engine, are installed. These are made entirely of composition and sheet brass, and each has a cooling surface, measured on the outside of the tubes, of 1,240 sq. ft. Air pumps are double-acting, one for each condenser, and driven from the main engine shafts. The circulating pumps are of the usual centrifugal type.

All shafting, piston, connecting, valve and eccentric rods, and working parts generally, are of the highest grade forged nickel steel oil-tempered and annealed. A test specimen, cut from each part, must show a tensile strength of not less than 95,000 lbs. per sq. in., an elastic limit of at least 65,000 lbs., with an elongation in 2 in., not falling below 21 per cent. In addition, a bending specimen must stand cold bending



LOOKING FORWARD

TRIPLE-EXPANSION ENGINE U. S. TORPEDO BOATS.

double to an inner diameter of 1 in. without showing cracks or flaws.

Steam is to be furnished by by three coil, or tubulous boilers, each with separate smoke-pipe, and having at least a total grate and heating surface of 137 and 7,544 sq. ft. respectively. The boilers, as laid down in the Department's design, are of the Thornycroft pattern, but the successful bidder is free to adopt any other type, subject to the approval of the Bureau of Steam Engineering. Certain essential requirements, however, in any design submitted must be complied with as follows:

1. Boilers to be built for a working pressure of 250 lbs., and of sufficient capacity to supply steam, under forced draft, for all machinery at full power.
2. Tubes forming heating surface to be seamless cold-drawn steel.
3. All steam and water drums to have longitudinal seams welded, and where possible, circumferential seams to be welded also.
4. Efficient means to be provided for getting at the interior of such parts of the boiler as require attention for examination, cleaning, or repair.

In addition to the main machinery as described, the following auxiliaries are to be installed, viz.:

Two main feed pumps of 147 gallons capacity per mt., one aux. feed pump of 147 gallons capacity per mt., one fire and bilge pump of the same capacity, also three blowers and engines, and two evaporators and one distiller.

The weight of all the above machinery, including auxiliaries and water in boilers, condensers and pipes, and such stores and spare parts as may be carried on board when fully equipped, is not to exceed 79.7 tons.

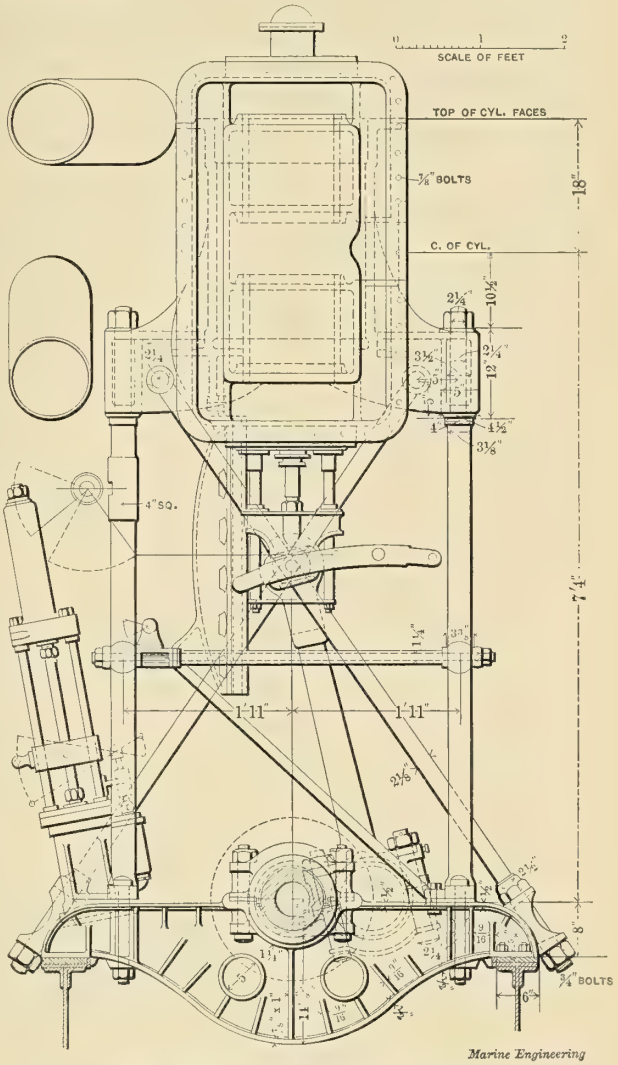
The battery of each torpedo-boat consists of three 3-pounder rapid-fire guns. Each vessel is also provided with three torpedo tubes and an outfit of five short Whitehead torpedoes, 3.55 metres in length. Two of the torpedo tubes are placed amidships, one on either side, and the third arranged for astern discharge. All ordnance weights, when completely supplied, amount to 12.7 tons and include the battery, ammunition, small arms, torpedoes, spare war heads, tubes, air compressor and its accumulator and piping, handling and transporting appliances, spare parts and accessories.

TORPEDO-BOAT DESTROYERS.

As shown in the Department's plans, the torpedo-boat destroyers have a draught of about 8 ft., with principal dimensions as follows:

Length on normal load water line	245 feet.
Beam " " " "	23 feet.
Displacement on trial about	420 tons.

The mild steel outside plating is generally of 9 lbs. per sq. ft., lapped seams and double riveted, for two-thirds the length amidships, reduced to 7 lbs. and single riveted at either end, with a nickel steel sheer strake of 12 1-2-lb. plate, reduced to 10 lbs. forward and aft; garboard strakes are of 10 lbs. amidships, reduced to 8 lbs. at ends, and flat keel of 12 1-2 lbs. for two-thirds the amidships length, reduced to 10 lbs. at bow and stern. The vertical keel is of 10-lb. plate.



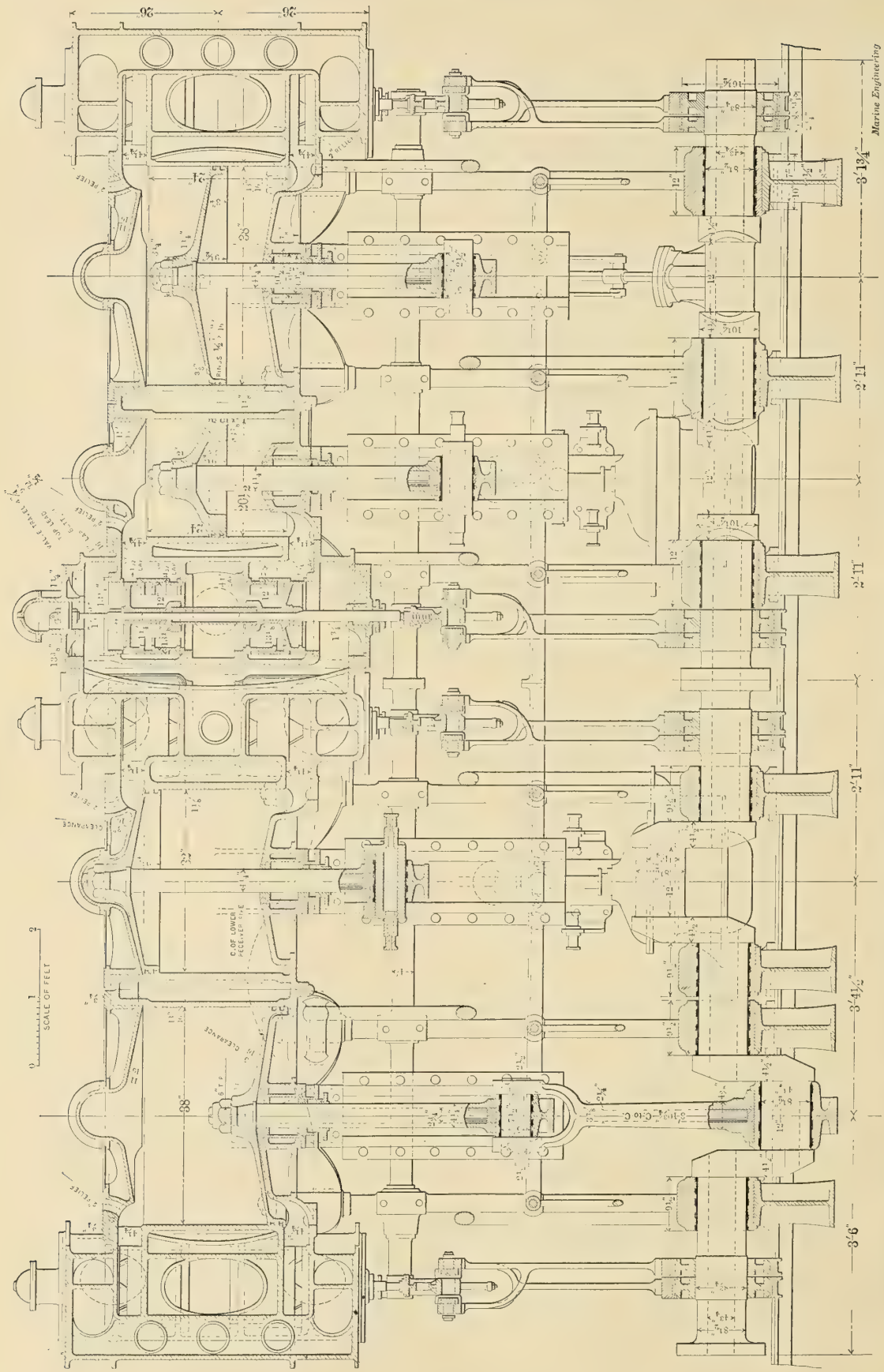
HIGH PRES. CYL. LOOKING FORWARD

TRIPLE-EXPANSION ENGINE U. S. DESTROYERS.

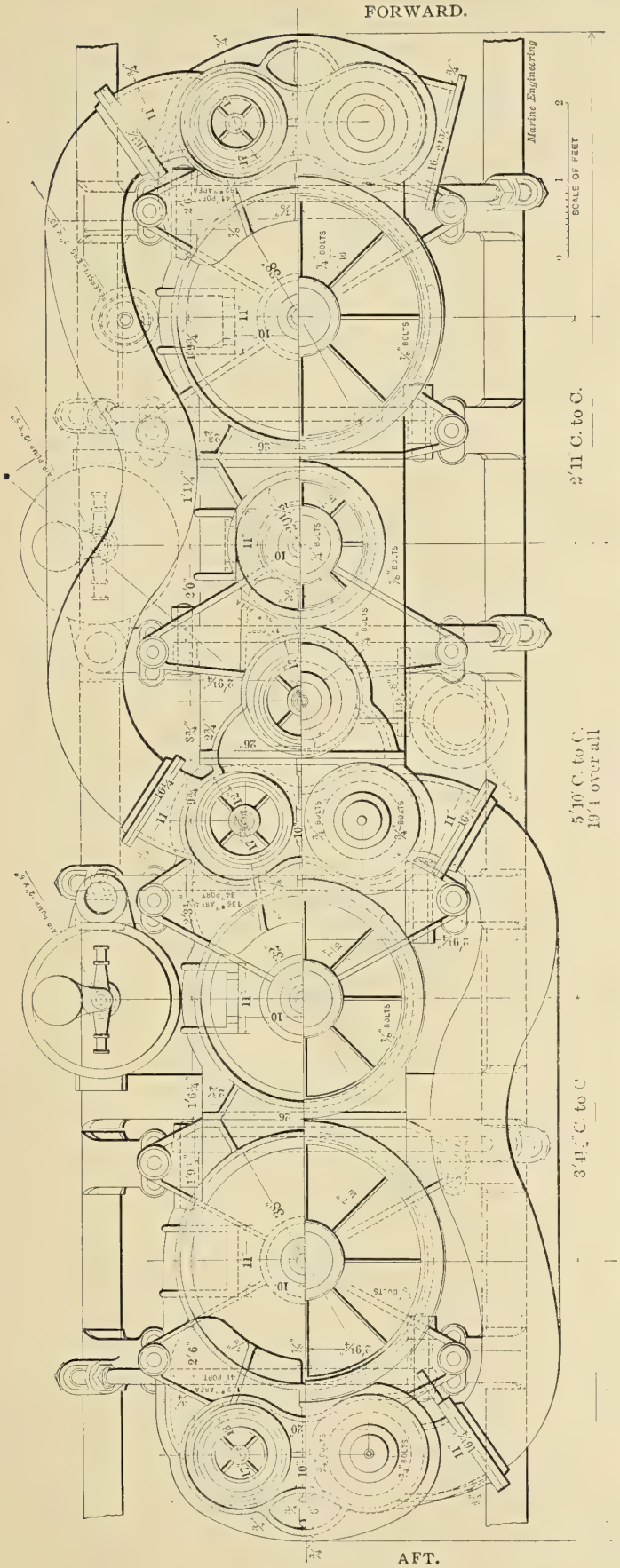
Transverse frames are spaced 21 in. from center to center, except in the engine compartments, where additional frames are worked or the spacing changed to suit the requirements of the engine beds. Bulb angle bars, in one length from deck to keel, form the frames. These are 2 1-2 by 1 1-2 by 3 lbs. per ft. in engine and boiler spaces, reduced to 2 1-2 by 1 1-2 by 2.2 lbs. elsewhere.

Floor plates of various depths, depending on location, are attached to every frame. These are of 8-lb. plates in machinery space, reduced to 5 lbs. at ends, with reverse bars, varying from 2 by 1 3-8 by 1 1-2 lbs. to 1 1-4 by 1 1-4 by 1 1-4 lbs., and extending from side to side.

Fore and aft coal-bunker bulkheads are formed of horizontal strakes, as long and wide as practicable, with edges and butts lapped, the former single, and latter double riveted. The lower



SECTIONAL ELEVATION FOUR-CYLINDER TRIPLE-EXPANSION ENGINES FOR U. S. TORPEDO BOAT DESTROYERS—BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT, PLANS.—PORT ENGINE.



PLAN OF FOUR-CYLINDER TRIPLE-EXPANSION ENGINES FOR U. S. TORPEDO BOAT DESTROYERS.

strake is of 7-lb. plate; the upper 12 1-2-lb. nickel steel, 18 in. in width, with plating between of 5 lbs. Vertical stiffeners are disposed on the inside, one to each frame, 2 1-2 by 1 1-2 by 2.2 lbs., and also a longitudinal, at mid-height on the outside, of the same dimensions.

Deck beams, one to each frame, have a crown of 10 in. in 23 ft., except beams for berth deck, which are without crown. The main deck beams are bulb angles 2 1-2 by 1 1-2 by 2 2-3 lbs. when not cut for hatches. Beams which are cut, and beams for forecastle and berth decks are 2 1-2 by 1 1-2 by 2.3 lbs.

The main deck plating is 7 lbs. to the sq. ft., with a 12 1-2-lb. stringer of nickel steel worked on each side over the ends of beams, and extending from forward to the after boiler-room bulkhead, after which a reduction to 8-lb. mild steel plate is made. Berth and forecastle decks have stringers of 7-lb. plate, with plating between of 5 lbs.

Bilge keels, made of I-beams, 8 by 4 1-4 by 18 lbs. per ft., with the lower flange removed, are fitted. These extend well beyond the limits of boiler and engine spaces, in a fore and aft direction, and so placed as to meet the least resistance in passing through the water.

The floor and bulkhead plates, reverse frames, frames and outside plating, to 1 ft. above the normal water line, vertical keel plates and bilge keels are to be galvanized by the hot process.

The propelling engines (shown in the scale drawings here published), which drive twin screws, are alike, placed in separate water-tight compartments, of the four-cylinder triple-expansion type, and designated for 8,000 horse power when running at 327 revolutions per mt., the steam pressure at the engines being 250 lbs. per sq. in. above the atmosphere. Each engine has a high-pressure cylinder of 20 1-2 in. dia., an intermediate pressure cylinder of 32 in. and two low-pressure cylinders of 38 in.; the stroke of all pistons being 22 in.

The order of cylinders, beginning forward, is, for the starboard engine, second low pressure, intermediate, high, and first low pressure; for the port engine, first low pressure, high, intermediate and second low pressure. Cranks are at 90 deg.,

the high and first low pressure being opposite, as are the intermediate and second low, the first pair being at right angles with the second. The object of this arrangement is to secure balance, and with this end in view the different pistons are so proportioned as to make the weights of the reciprocating parts the same for all cylinders.

All main valves are of the piston type, worked by double bar links, one for the high pressure, two for the intermediate and two for each low pressure. Each valve is made of two turned and polished heads, or pistons, without packing rings, the distance between the two being such as to produce the steam and exhaust lap required.

The engine framing consists of twelve forged steel columns, 3 1-8 in. dia., stiffened by horizontal tie-bars and stayed by diagonal braces, 2 1-8 in. dia. Bedplates are separate steel castings of I-section for each bearing, with webs of 1-2 in. thickness, supported upon and bolted to two fore-and-aft plates, which latter, worked into the framing of the vessel, form part of the engine keelsons. Only bottom crank shaft brasses, lined with white metal, are used, the bronze caps (also lined with white metal) taking the place of top brasses.

There is a condenser for each engine having a cooling surface, measured on the outside of the tubes, of 3,470 sq. ft. The shells are of sheet brass, No. 10 B. W. G. thick, made of sheets as large as procurable brazed together, with two stiffening rings of T-section for each condenser shell. Tube sheets are 3-4 in. Muntz metal, with 2,292 holes in each for the tubes, which latter are 5-8 in. outside dia., No. 20 B. W. G. thick, spaced 15-16 in. between centers, and 9 ft. 3 in. in length between tube sheets.

The air pumps, two for each engine, are vertical, double-acting, worked from the high and intermediate crossheads, and have water cylinders 12 in. dia., with a stroke of 6-in. For each condenser there is one water-balanced, centrifugal circulating pump, having a pump runner 20 in. dia., capable of discharging 2,000 gallons of water per mt. when connected to the bilge, and driven by a vertical single-cylinder engine of 4 1-2 in. dia. and 5-in. stroke.

The crank shaft of each engine is forged solid, in two sections, one 8 ft. 11 in., the other 9 ft. 10 in. long, with two cranks on each section placed opposite. Each shaft has seven journals, of which four are 9 1-2 in., two 12-in. and one 14 in. long. The shafts and crank pins are 8 1-2 in. dia., with an axial hole of 4 3-4 in., and are to be made of nickel steel of at least 80,000 lbs. tensile strength, not less than 50,000 lbs. elastic limit, and a minimum elongation, in 2 in., of 25 per cent.

Thrust, line and propeller shafts are 7 7-8 in. dia., with a 4 3-4 in. axial hole. These, as well as the working parts of the engines, are of nickel steel, with physical requirements the same as stated for similar parts in the torpedo-boats.

There are to be four boilers of the tubulous type, built to carry 300 lbs. steam pressure, each with separate smoke-pipe, the latter being oval in shape, and 18 ft. above the deck. The total grate and heating surfaces, of all boilers, is to be at least 315 and 17,768 sq. ft. respectively, and with these limitations, and subject to the requirements in other respects mentioned for the torpedo-boat boilers, the contractor is free to adopt any make. Two of the boilers are forward, the remaining two abaft the engines, and arranged in two water-tight compartments, with one fireroom for each pair of boilers.

The following auxiliary machine is to be fitted, in addition to that already mentioned: Four vertical, single-cylinder, main feed pumps, each with a steam cylinder of 10 in., 6-in. water cylinder and 12-in. stroke, and located one in each fire and engine room; one auxiliary feed pump, of the same size, placed in each fire room; one vertical, single-cylinder, fire and bilge pump, with steam cylinder of 6 in., water cylinder of 8 in. and stroke of 12 in., placed in each of the engine rooms; two blowers with necessary engines in each fireroom, and of sufficient size to maintain the maximum rate of combustion with ease under forced draft when discharging into closed firerooms; two feed heaters, one in each engine room, containing about 175 sq. ft. of tube heating surface in each; one hydraulic ash ejector in each fireroom; a fresh-water plant, consisting of two evaporators and one distiller, with a maximum capacity of 1,500 gallons of water for each of the former, and 200 gallons of potable water in 24 hours for the latter; there is also a small combined evaporator feed and brine pump, and a distiller circulating pump of rated capacity of 30 gallons per mt. installed in connection with the plant.

All machinery, including auxiliaries, water in boilers, condensers, pipes and feed tanks, stores and spare parts, when the vessel is fully completed and ready for service, is not to exceed 190 tons.

Each destroyer is fitted with two torpedo tubes and four long 5-metre Whitehead torpedoes, with a battery composed of two 12-pounder and five 6-pounder rapid-fire guns. The total ordnance weights, when fully equipped, and which includes similar details mentioned for the torpedo-boats, is to be 23 1-2 tons.

Following are the lists of the contracts let:

TORPEDO BOATS.

Name of Bidder	Location of plant	No. of vessels	Design	Price of each vessel
Trigg & Co.	Richmond, Va.	3	Depts.	$129,750
Gas Eng. & Power Co.	Morris H'g'ts, N.Y.	1	Depts.	146,000
Lawley & Sons	Boston, Mass.	2	Depts.	159,400
Bath Iron Works	Bath, Me.	3	Bidders	161,000
Lewis Nixon	Elizabethport, N.J.	2	Bidders	165,000
Columbian Iron Works	Baltimore, Md.	1	Depts.	168,000

TORPEDO BOAT DESTROYERS.

Name of Bidder.	Location of plant	No. of vessels	Design	Price of each vessel
Trigg & Co.....	Richmond, Va.....	2	Depts.	$260,000
Fore River Engine Co..	Weymouth, Mass..	2	Bidders	281,000
Gas Eng. & Power Co..	Morris H'g'ts, N.Y	1	Depts.	282,000
Neafie & Levy	Philadelphia, Pa...	3	Depts.	283,000
Union Iron Works.....	San Francisco, Cal.	3	Depts.	285,000
Maryland Steel Co.....	Baltimore, Md.....	3	Bidders	286,000
Harlan&Hollingsworth	Wilmington, Del...	2	Bidders	291,000

The above tables are corrected to date, and show the successful bidders, the number of vessels allotted to each, the design under which they are to be built and the contract price.

Experience with Outboard and Inboard Turning Propellers on S.Y. Niagara.

The following valuable information has been contributed by T. Jackson Shaw, Superintending Engineer of the Harlan and Hollingsworth Co., in a letter to the Editor of the Journal of the American Society of Naval Engineers.

I would like to give what may be interesting data on three trials of the twin-screw steam yacht Niagara,* built by the Harlan and Hollingsworth Co., for Howard Gould.

The dimensions of the yacht are as follows: Length between perpendiculars, 247 ft. 6 in.; beam, 36 ft.; depth to the spar deck, 28 ft. 2 in.

On trial our draught of water was 17 ft. aft and 15 ft. 9 in. forward. The total displacement was 2,240 net tons. This weight included 400 gross tons of coal, 15,000 gallons of water in tanks, and all stores and outfit on board. The yacht is designed with the Lundborg shaft carriers instead of struts.

After careful consideration as to the direction to run the engines—as to turning the wheels inboard at the top or outboard, and making inquiry from different sources on this subject—also having learned that the British Admiralty were building battleships on the other side with tops of the wheels turning inboard, I concluded to follow out the same on the Niagara.

The engines are of the triple-expansion type, having three cylinders, 18 in., 28 in., 45 in. by 30 in. stroke. Boilers three in number, Scotch type, having a total of 204 sq. ft. of grate, and built for a working pressure of 160 pounds per square inch.

We burned on the trials good quality of hard coal with natural draft, she having no appliances for forced draft.

The first wheels were 10 ft. in diameter, 13 ft. pitch, having a Griffith-shape blade.

The result of the first trial was as follows:

The average revolutions of the engines, 128; average steam pressure, 156; average speed, 12.54 knots; the course being from Scotland Light Ship to Barnegat. The slip of the wheels, you will see, was 23.6 per cent.

After thinking over the matter, I concluded in my own mind that the Lundborg extensions prevented the water from getting to the wheel properly, and I decided to increase the diameter of the wheels 6 in., increase the blade area on the points, and increase also the pitch to 14 feet. This was done, the ship docked, and the new blades put on, but no change was made as to turning the engines in the opposite direction. With this change in the wheels, over the same course, the ship on the same draught, we made an average speed of 12.8 knots on an average revolution of 126, showing the slip to be in this case 26.4 per cent.

After this trial I immediately decided to run the wheels in the opposite direction, the guides of the engines being of such design that this could be done very readily. I therefore docked the ship, put the starboard wheel on the port engine and the port wheel on the starboard engine, with the result on trial on August 16, the ship being still in the same condition of draught, etc., as follows:

Our average speed was 14.12 knots, our average revolutions being 118, which gave a slip of 13.3 per cent.

We did not indicate the engines on any of these trials, so that I can give you no data as to H. P., other than I should assume that we were developing on the first trial about 2,200 H. P., on the second trial about 2,100 H. P., and on the third trial about 1,950 H. P.

The keel is carried straight back to the rudder pintal in the usual way, and there is no well or opening through the deadwood abreast of the wheels.

*A technical description of the Niagara, with plans, will be found in our issue of April 1898.—Editor.

Lake Ships for Atlantic Coast Trade.

Considerable interest and speculation has been created during the past few weeks among vessel owners on the Great Lakes and along the Atlantic coast, by a large movement of lake vessels to the coast for use in the coal trade.

Several weeks ago Walter S. Besse, General Manager of the Atlantic Transportation Company, with offices in New York, made his appearance rather suddenly at Cleveland and very quietly, but in a remarkably short time, secured options from a number of lake vessel owners for the chartering of their boats for a term of years for coast trade service. The proposition was one quite new and was looked upon with considerable incredulity by the lake owners; but, as Mr. Besse was able to convince them of the excellent financial standing of his company, and, as most of the vessels desired were of the class that are fast becoming obsolete as dividend producers on the lakes, the options were readily given. As soon, therefore, as Mr. Besse had convinced himself, by a personal inspection of the locks and rapids through which the boats must pass in going from the lakes to the coast, that the scheme was practical, formal charters were closed for thirty-nine schooners and four steamers, the schooners ranging in size from

a capacity of 1,200 gross tons of coal to 2,500 gross tons, and the steamers from a capacity of 1,700 tons to 2,500 tons. The vessels are all of the older type of wooden ships. Charters are for terms ranging from two to five years, and include an agreement to keep the vessels insured on an agreed valuation and securing from the owner the option of purchase at any time during the charter term.

The Atlantic Transportation Company has a four year contract with the Chesapeake & Ohio Railroad Company for the transportation of all the latter's coal from Newport News to New York and New England ports, and it is in the handling of this business that these vessels will be used, together with a large fleet which the company already owns and has under charter.

The result of the advent of these vessels on the coast is problematical, as the vessels are to be used only in the transportation of coal controlled by this company; but the introduction of this extra tonnage will undoubtedly have more or less effect upon the business done by vessels in the coast trade.

The result on the lakes will undoubtedly be more marked, as the taking of so large a tonnage from the lakes (70,000 tons carrying capacity) at this time of year, when shippers are crowding their products forward in order to clear up the business of the year before the closing of navigation, and at the time of year when rates almost invariably advance, will undoubtedly make this advance more marked, and will, in all probability, induce the building of several new and modern lake carriers.

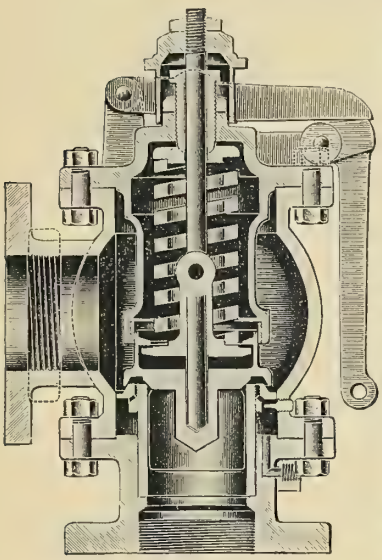
There is here printed a complete list of the vessels chartered, their respective tonnage, and the valuations placed upon them and owners:

Steamers.	Capacity Net Tons.	Insurance Valuation.	Chartered From.
Aragon	2,500	$100,000	C. R. Jones, Cleveland
Lindsay	1,700	68,000	C. R. Jones, Cleveland
Katahdin	2,200	100,000	H. W. McCormick, Bay City
Murphy, S. J.	2,200	100,000	L. H. McCormick, Menominee
Barges.			
Foster, Chas.	2,000	25,000	J. C. Gilchrist, Cleveland
Georger, F. A.	1,700	18,000	" "
Alverson, H. D.	1,500	18,000	" "
Moonlight	1,500	17,000	" "
Crosthwaite, W. S.	1,400	14,000	" "
Sheldon, T. P	1,300	14,000	" "
Bacon, M. S	1,300	18,000	" "
Watson, S. L.	1,200	12,000	" "
Foster, S. H.	1,300	16,000	" "
Verona	1,400	15,000	" "
Camden	1,400	15,000	Jno. F. Wedow, Cleveland
Halloran	1,500	16,000	Thos. Murphy, Cleveland
Massasoit	1,200	14,000	Leander Burdick, Toledo
Sage, H. W.	1,500	20,000	Jno. Kelderhouse, Buffalo
Redwing	1,500	16,000	A. A. Parker, Detroit
San Diego	1,500	16,000	" "
Iron State	2,000	30,000	J. W. Millen, Detroit
Iron City	1,200	22,500	" "
Watson, S. V. R.	1,000	10,000	Byron Whitaker, Detroit
Parker, Thos. L.	1,200	20,000	C. W. Elphicke, Chicago
Wadena	2,100	35,000	Mack-Becker Fleet, Cleveland
Becker, W. D.	2,100	48,000	" " "
Ash, Annie M	2,500	46,000	" " "
Checotah	1,400	16,000	Alvin Neal, Port Huron
Wallace, David	1,800	27,000	David Wallace, Lorain
Wall, Charles	1,200	9,000	C. R. Jones, Cleveland
O'Neil, John	1,200	10,000	" "
Brunette	1,400	12,000	" "
Shawnee	1,200	10,000	J. W. Westcott, Detroit
Hawgood, H. A.	2,300	42,500	Hawgood & Avery, Cleveland
Ewen, F. D.	1,900	32,500	" " "
Fitzpatrick, J. C.	2,400	55,000	Thos. Fitzpatrick, Cleveland
Metacomet	1,500	18,000	Inter Ocean Trans. Co., Milwaukee
Rutter, J. H.	1,800	25,000	Thos. Adams, Detroit
McGregor, Wm.	1,500	17,000	Northwest Trans. Co., Detroit
Brown, H. H.	1,500	17,000	" " "
Porter	1,500	16,000	C. A. Chamberlin, Detroit
Helvetia	1,600	18,000	H. J. Johnson, Cleveland
Page, M. W.	1,400	16,000	V. Fries, Milan, Ohio
	69,500	$1,184,500	

The Thingvalla Line has been purchased by the United Steamship Co., of Copenhagen, and will in future be known as the Scandinavian-American Line. A regular service between New York, Christiania, Copenhagen and Stettin will be maintained with the old fleet, which includes the steamships Hekla, Norge, Island and Thingvalla. The new owners announce that a fleet of new and fast ships will be built.

IMPROVED APPARATUS.

Improved Pop Marine Safety Valve.



MARINE SAFETY VALVE.

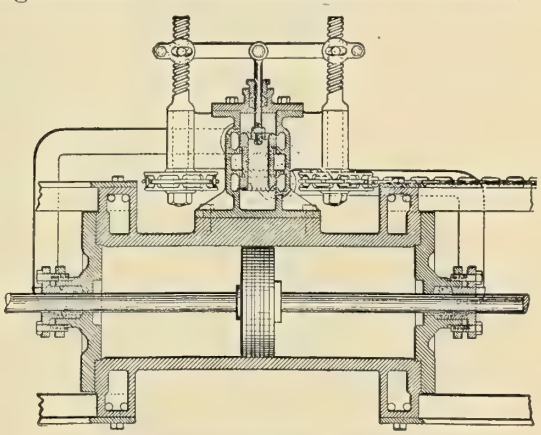
A section of the Scott improved Marine Pop Safety Valve here printed shows the method of construction. This valve is made with a bevel seat to an angle of 45 degrees, and is provided with a cam lever for raising the valve off its seat when no pressure is on, or blowing off all the steam when desired, as required by the rules and regulations of the United States Board of Supervisors and Inspectors of Steam Vessels. It has been approved by the Treasury Department on a basis of one square inch of valve area to two square feet of grate surface. It is so constructed that the spring is isolated from the steam. The outlet of the valve can be piped to any desired point of discharge, such as into the condenser hot-well, supply tank, or through the side of the ship and under the water-line, thereby dispensing with the noise while blowing off, and without affecting the efficiency of the valve or changing its point of opening or closing. Access to the valve can be had without interfering with outlet pipe. This valve is manufactured by the Roe Stephens Mfg. Co., Detroit, Mich.

Waters Steam Steering Engine.

A direct acting steam steering engine is manufactured by George H. Waters, which is guaranteed to hold the rudder in any position and to be perfectly noiseless. It is a compact form of gear which can be hung from the deck so that the floor space underneath is clear of any obstruction. The valve and cylinder mechanism is clearly shown in the accompanying engraving. At either end the piston rod is attached to a traveling block working in a frame on slides and these blocks carry the rudder chains. The objection of "condensation" which is made to steam "direct gears" is met by an arrangement which, according to the inventor, insures accuracy of the gear when the wheel is held long in one position. The steam valve is moved from the pilot house to admit steam to either end of the cylinder, according to the direction required, and the piston in response moves to a certain point, according to the amount of opening given the valve. While the piston is moving to this point it moves a chain attached to the piston rod, or to the traveling block, and working over a chain wheel attached to the governor side of the valve. The movement of this chain wheel brings the valve back to a central position at all times. In case the hand wheel in the pilot house should be held in one position for a considerable length of time, and the piston was to shift from condensation it would simultaneously move the chain wheel on the governor side and admit steam so that the piston would be moved back to the original position. These gears are guaranteed to be very economical in the use of steam. One of them is in use on the Erie Railroad Ferryboat John King, in the North River, and is said to have given complete satisfaction. The address of the inventor and patentee, George Waters, is 201 River St., Hoboken, N. J.

C. & C. Electric Generating Sets.

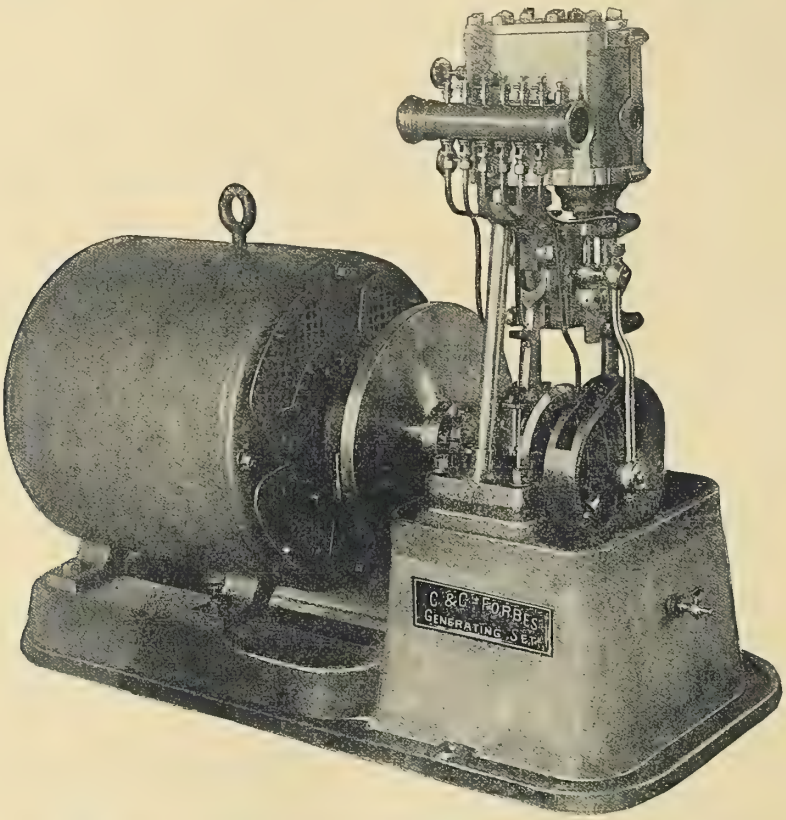
In response to an increasing demand for iron-clad dynamos connected to Forbes vertical engines the C. & C. Co. has recently designed a full line of such sets, ranging in capacity from $3\frac{1}{2}$ to $16\frac{1}{2}$ K.W. which are now ready for the market. Several of these outfits have already been sold and placed in operation with highly satisfactory results. The Forbes engine has been designed with the idea of producing an engine simple in its construction, large in its wearing surfaces, close in its regulation and in fine running balance. The makers have not resorted to



WATERS STEERING ENGINE.

any cheap workmanship or material, feeling sure that nothing but the best should be used in a high speed engine. All the forgings are of steel, forged without welds, metallic packing is used on valve stems and piston rod, and the governor is made under the Rites patent. The lubricator is easily adjusted and thoroughly efficient. While sacrificing nothing in the way of strength it is the lightest engine for its horse-power commercially made. The dynamo employed in these sets possesses many recommend-

ations for marine work, where dynamos are as a rule put in close quarters and where the machine is often liable to injury either through accident or through becoming wet. The cylindrical field frame of the dynamo, which forms the largest part of the casing, is of soft cast steel in one piece with the four pole pieces. The two end plates which are bolted to this case or frame carry the two self-oiling and self-aligning bearings, besides one of them carrying on the commutator end a shoulder to which is secured the brush holder spider. The field coils are carefully wound on metal spools or bobbins, and the whole well insulated. The armature is most substantially built and is well arranged for ventilation, while the commutator is of ample proportion, and its segments of 98 per cent copper.



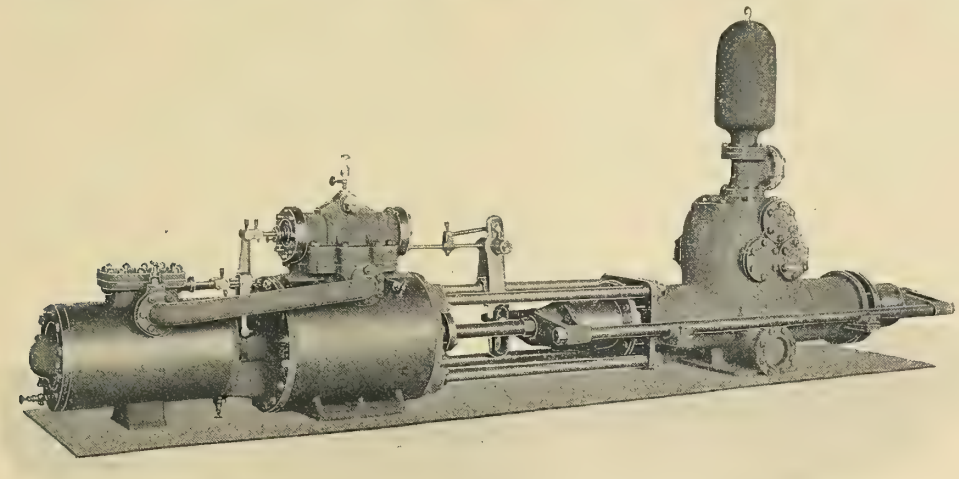
C. & C. DYNAMO AND FORBES' ENGINE—DIRECT CONNECTED.

Brush holders are of the well known "improved reaction" type, through which just the proper tension is at all times applied to the carbon brushes. The design and operation of this dynamo are both so calculated that no brush movement is required under any load or load change, and there is no objectionable sparking at the brushes. In neither the closed or the open type is there any injurious heating. Both types are the same, except that in the open type the four openings in each end plate are fitted with perforated hand plates, while in the closed type these plates are solid. Of course, it is necessary to be more conservative in the rating of the machine where it is absolutely inclosed to keep the heating effect within safe limits. For example, the same frame which is wound for 5½ K.W. as an open type, is wound for 4½ K.W. where the machine is to be closed. The closed type is entirely dust proof and waterproof, and particularly adapted for steamer lighting, yet the open type fills most requirements equally as well. In the illustration here shown, the open type dynamo is used. The outfits are manufactured by the C. & C. Co., 143 Liberty street, New York.

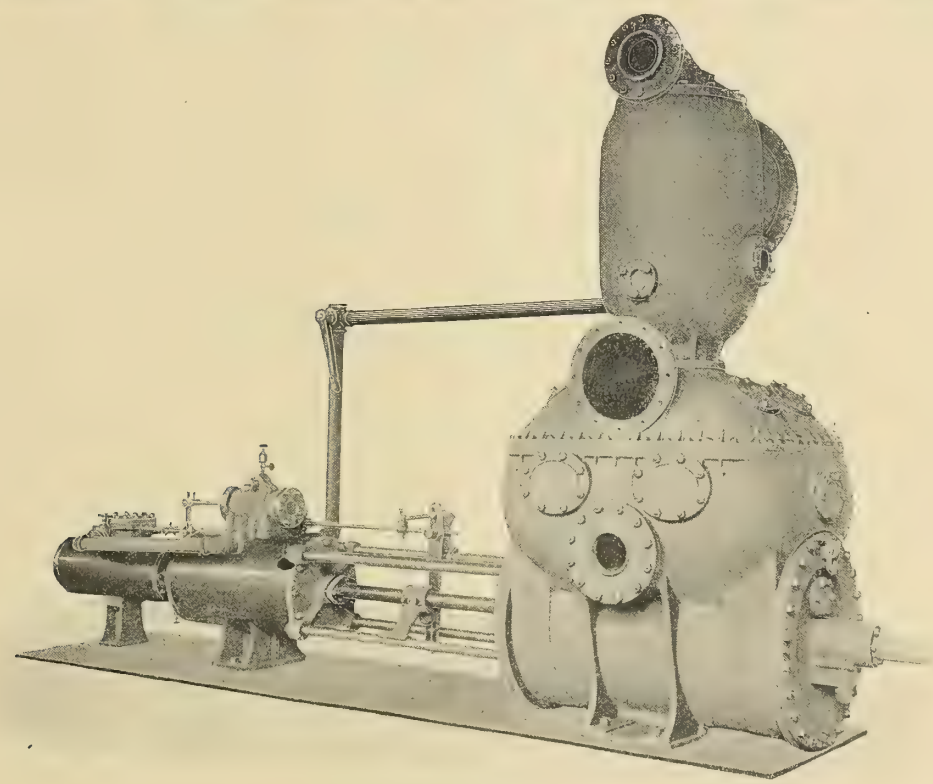
Pumps for Lake S.S. S. F. B. Morse.

The illustrations show two steam pumps made by Dean Bros. Steam Pump Works for the Bessemer Steamer S. F. B. Morse, the largest vessel on the Great Lakes. The boiler feeder has compound steam cylinders and outside packed plungers. The high pressure steam cylinder is 12 in. dia., low pressure cylinder 13 in. dia. by 20 in. stroke. The pump end is of the "trombone" pattern with bronze plungers 10 in. dia. by 20 in. stroke. The plunger cross heads are of cast steel. As the working steam pressure is 200 lbs. per square inch the pump cylinder is cast in one piece to avoid danger from leaky joints. The air pump and condenser has compound steam cylinders 10 in. and 16 in. dia., by 30 in. stroke. The air pump cylinder is double acting, 30 in. dia. by 30 in. stroke. It is lined with heavy bronze and has

bronze piston rod. At the outer head it is provided with a bronze tail rod for carrying the weight of the piston. The shoe to tail rod has external means for adjustment in case of wear. In the cylinder head there is a hand hole plate for examining the inside of the cylinder without removing the head. The flange shown on the side of the cylinder is for the bilge pipe connection, so that in an emergency the air pump may be used as a water pump for pumping out the vessel. The exhaust pipe from the steam cylinder is carried into the condenser, it has a three way cock with a lever for changing the exhaust to the open air if necessary. The propelling engine from which the condenser takes steam is of the quadruple-expansion type with cylinders 26 1-2 in., 37 in., 54 1-2 in. and 89 in. dia. and 42 in. stroke. All of the other pumping machinery for this lake carrier, including two ballast pumps, one fire pump, one bilge pump and a cooler pump, was furnished by Dean Bros. Steam Pump Works, Indianapolis.



DEAN BOILER-FEED PUMP FOR LAKE S.S. S. F. B. MORSE.



DEAN AIR PUMP AND CONDENSER FOR S.S. S. F. B. MORSE.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building, New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.
S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representative.
L. L. CLINE, Detroit, Mich., 47 Hodges Building.

Traveling Representatives.
E. L. BLANCHARD. J. E. WHITTLESEY.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

UNUSUAL interest attaches to the forthcoming meeting of the Society of Naval Architects and Marine Engineers in consequence of the recent naval operations in the Spanish war. The Society has made arrangements, indeed, for a very complete discussion of problems in construction and operation of naval vessels upon which original information has been had in blockade duty and sea fights, chiefly in the Caribbean Sea. November 10 and 11 are the days of the meeting, and through the courtesy of the American Society of Mechanical Engineers the members will come together in the auditorium at 12 West Thirty-first street, New York. The list of papers to be read each day contains in itself many professional matters of timely interest, and this is added to by the selection of the subjects for topical discussion. For Thursday, November 10, the programme, arranged by Sec.-Treas. Francis T. Bowles, reads:

1. Torpedo-Boat Destroyers for Sea Service, with Special Reference to the Conditions that Prevail on the Pacific Coast.

By G. W. DICKIE, Esq., Member.

2. The Standard Navy Boats.

By ARTHUR B. CASSIDY, Esq., Member.

3. Bilge Keels and Rolling Experiments U. S. S. Oregon.

By Asst. Naval Constructor LAWRENCE SPEAR, U. S. N., Member.

4. Steam Economy Test of a Unique Form of Feed Pump.

By F. M. WHEELER, Esq., Member.

5. Portable Pneumatic Riveters in Shipbuilding.

By W. I. BABCOCK, Esq., Member.

Topical discussions of the following questions:

1st. The utility of Torpedo-Boats, and has the Sub-Marine Boat a place?

2d. In what respects have the recent Naval Engagements affected opinion as to the value and best distribution of armor for war-ships?

For the day following, Friday, November 10, the list includes:

6. The Steam Yacht as a Naval Auxiliary.

By WILLIAM P. STEPHENS, Esq., Associate.

7. Designs of the New Vessels for the U. S. Navy.

By Chief Constructor PHILIP HICHBORN, U. S. N., Vice-President.

8. Methods of Securing Water-tight Work.

By Asst. Naval Constructor H. G. SMITH, U. S. N., Associate.

9. Tests of the Strength of a Longitudinal Bulkhead Separating Two Engine Rooms.

By Naval Constructor J. J. WOODWARD, U. S. N., Member.

10. An Electrically Operated 150 Ton Revolving Derrick.

By WALTER A. POST, Esq., Associate.

11. Stability of a Battleship under Damaged Conditions.

By Prof. CECIL H. PEABODY, Member.

Topical discussions of the following questions:

1st. Under the circumstances of the Blockade at Santiago, which was the more economical method of maintaining the boilers in readiness for immediate action—banking the fires or keeping them spread but very thin?

2d. Can you give any data as to the cost in coal of maintaining the engines and boilers in readiness for immediate service?

3d. What, if any, difficulty was there in maintaining the supply of fresh water for the boilers; and, if there was any difficulty, to what do you attribute it?

4th. As a result of experience on the Blockade, what particular points about the machinery were most likely to give trouble, and what could be done to prevent a recurrence of such trouble?

Present indications are that this, the sixth annual meeting will be probably the most largely attended ever held by the Society. Every member who can possibly attend will find in this meeting the pleasantest experience of the year, and others who are interested, will, as guests of the Society, be cordially welcomed and given opportunity to take part in the discussions.

OF special interest are the official returns covering domestic shipbuilding and merchant shipping for the year ending June 30 last, prepared in the office of Mr. E. T. Chamberlain, Commissioner of Navigation, Treasury Department, Washington. These will soon be published in the regular annual report. Meanwhile we give an abstract of the complete returns, which show that the documented American merchant shipping on June 30, 1898, comprised 22,705 vessels of 4,749,738 gross tons, compared with 22,633 vessels of 4,769,020 tons on the like date in 1897. The decrease of 19,282 tons is more apparent than real, as 11,000 tons of this amount is due to dropping fractions of tonnage in the accounts, and 66,713 tons were sold to the Navy and War Departments to carry troops, supplies and provisions, and have merely changed employers. The total steam tonnage amounts to 6,712 vessels of 2,371,923 tons, compared with 6,599 vessels of 2,358,558 tons for the previous year. The vessels sold to the government were all steam vessels, so the true increase is greater than the figures indicate. Sailing vessels have decreased from 1,904,153 tons for 1897 to 1,835,827 tons for 1898. Documented canal boats and barges amount to 541,988 tons, compared with 506,309 tons for the previous year. The increase is chiefly in barges which are superseding sail vessels, especially in the coal trade. Tonnage on the Atlantic and Gulf coasts has dropped from 2,647,796 tons for 1897 to 2,553,739 tons for 1898. The Great Lakes tonnage shows a slight increase, 1,437,500 tons compared with 1,410,103 tons. The new Alaskan trade has increased the Pacific coast marine from 439,012 tons to 496,767 tons. Western rivers have decreased from 272,109 tons to 261,732 tons. New York State retains the first place with tonnage reduced from 1,331,743 to 1,299,825 tons, Michigan is still second with a reduction from 477,602 to 458,100 tons, and Ohio stands third with 395,618 tons, an increase of about 6,000 tons. The greatest increase is in Washington, from 97,796 to 152,167 tons, and Alaska from 3,824 to 9,755 tons. New England shows a large decrease, and the Gulf States an appreciable increase. Vessels registered for foreign trade number 1,136 of 737,709 tons, compared with 1,230 of 805,584 tons for 1897. These figures are the lowest since 1832. The decrease is wholly in sail vessels of which 159 of 103,000 tons, or about 20 per cent have been lost, laid up or gone into domestic trade during the year. Registered steam vessels have increased from 222,136 tons to 245,059 tons. Through the greater efficiency of steam vessels our fleet for the foreign trade does not show a decrease in carrying power. The effect of the war is shown in the sale of 84 vessels of 35,411 tons to foreigners, compared with sales of 8,243 tons the previous year. The sales were chiefly due to high premiums on American vessels and cargoes, demanded by insurance companies during the brief period while mines and torpedoes were being placed in our harbors. The effect of the war is also shown in the admission by Acts of Congress of 27,824 tons of foreign vessels to American registry, chiefly for transport purpose. During the preceding eight years only 55,902 tons were so admitted. New documented tonnage constructed during the fiscal year ending June 30 last included 952 vessels of 180,458 tons as compared with 891 vessels of 232,233 tons during the previous year. An analysis of these figures showing the general

Geographical Distribution.	1897.		1898.	
	No.	Gross Ts.	No.	Gross Ts.
Atlantic and Gulf coast...	609	96,009	514	63,090
Pacific coast	64	7,495	228	49,789
Northern lakes.....	120	116,937	87	54,084
Western rivers	98	11,792	123	13,495
Total.....	891	232 233	952	180,458

Power and Material.	1897.		1898.	
	No.	Gross Ts.	No.	Gross Ts.
Sail:				
Wood.....	327	29,678	357	27,692
Steel	11	34,631	2	6,724
Steam:				
Wood.....	244	27,917	343	57,337
Iron and steel.....	44	78,236	51	48,501
Canal boats.....	70	10,216	20	2,386
Barges:				
Wood.....	182	40,027	169	30,777
Steel	13	11,528	10	7,041
Total.....	891	232 233	952	180,458

location of the yards, the materials of construction, and the form of power employed is printed in the tables herewith. There is now a great deal of activity in shipping circles, and building orders are plentiful in most of the Atlantic coast yards. Treasury Department statistics of commerce for nine months of this year, ending September 30, show that it will be a record breaker in the total of exportations. For the period between January 1 and September 30, 1898, the exports footed up $869,127,868, or $122,889,626 more than the figures for 1897.

CORRESPONDENCE.

[*Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.*

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Comment on Mr. Kyles's Paper on Marine Engine Repairs.

Editor Marine Engineering:

In your July issue I notice the extract fom a very interesting paper read before the Institute of Engineers and Shipbuilders of Hong Kong, by J. Kyles. M. E., entitled "Marine Engine Repairs Discussed in a Thoroughly Practical Way." While I fully agree with him in many particulars, there are certain methods described which appear antiquated in the light of the best practice here (transatlantic trade), and in other instances the author might, I believe, have given more details than are contained in the paper.

In the first place, in the item *Repairs to Cylinders*, the question is raised as to what is to be done with the piston after the cylinder has been rebored. The treatment as described consists in shrinking on a wrought iron or mild steel hoop with a V groove to prevent its coming off, and turning down the same to 1-32 inch smaller in diameter than the cylinder. This evidently refers to the lip of the piston, the repair, no doubt, including a new follower and packing rings.

The lip of the piston acts in the capacity of a solid piston ring as long as it fits the cylinder, but as soon as it gets slack it loses all its usefulness, except when supporting packing rings, and in that case a part of the lower packing ring is subjected to the full blast of steam at admission, which soon destroys the fit of the latter.

The better way of altering the piston after the cylinder is rebored consists in turning down the lip to a size of about 2 inches less in diameter than the cylinder, and let the new follower lap over it to the full depth of the piston. The follower bolts are usually strong enough to bear the pressure on the exposed edge of it on upstroke. The packing rings are then placed in the follower, and can be very easily overhauled by disconnecting the follower from the piston and lifting it out of the cylinder. In regard to Ramsbottom rings, it is the rule not to put spring rings behind them in cylinders less than 75 inches in diameter.

The following item, *Crankshaft Construction*, contains a detailed description of putting a new crankpin in the webs of a built-up crankshaft so as to get it true. Now for heavy, large jobs there is no use in running any risk of this kind; for the journals as well as the pins, bore out the holes in the webs somewhat larger, shrink in the pin or journals, and then turn them down to the proper sizes, and the shaft will be true. In connection with the subject of shafting, Mr. Kyle states that the coupling-bolt holes in new spare shafts are usually 1-4 inch smaller in diameter to allow for reaming, and suggests that it would save time if the shaft were taken to a machine to have the holes enlarged instead of doing it on board with the reamer.

I do not see why there is any occasion for the holes being so small. Every ship has, or ought to have, a template of the bolt holes in the couplings, as the holes are all laid out from a template when the engine is building; 1-16 inch is ample allowance, especially when it is considered that the old holes in the adjoining coupling will also be slightly reamed at the same time. The handling of a 15 ton crankshaft is a rather expensive operation, and the removal of a defective shaft and the installation of the spare one is very laborious, even when conditions are favorable.

Mr. Kyles asserts that 1-4 inch taper to the foot on a coupling bolt is entirely too little. Present practice demonstrates that 3-16 to 1-4 inch to the foot is ample. On a coupling flange, say 4 1-2 inches thick, with coarse taper bolts of proper shearing section, the large ends of the bolts diminish the section of coupling material at their pitch circle to the extent of causing weakness or fracture.

In the item, *Piston Rods*, Mr. Kyles deplores the fact that there is usually too little shoulder left where the piston butts on the rod, so that when the rod requires turning up there is no shoulder left, or if a collar is left, the gland and neck-bushes must be made in halves.

Evidently this case applies to piston rods which have a jaw holding the crosshead brass, a rather antiquated design for large jobs, as there is much labor entailed in removing or disconnecting such a rod. Even if the rod were trued up to the extent of removing the shoulder, there is no plausible reason why a good fitting taper on the rod should not hold a moderate sized piston perfectly secure without the assistance of a shoulder. In modern practice the use of a taper on a piston rod to hold the piston is gradually being abandoned, especially for large diameter cylinders, and instead a flange coupling is put on the end of the rod, holding the piston by means of fitted bolts, the stuffing-box plug in the bottom of the cylinder being made large enough in diameter to draw the rod out from below. The rod is attached to the crosshead with a taper and nut. With this construction it is very easy to take out a rod and put on glands and neck-bush without removing the piston, and it can be most appreciated when overhauling engines where two cylinders work tandem.

On the subject of *Valve Faces* the author of the paper suggests that in order to get good metal in a false valve face it is a good plan to cast the face solid and machine out the ports. To make this a general rule would be going to extremes. Where the ports have sharp corners or small fillets it is not a difficult matter to judge where cooling cracks are liable to occur, and if the face is cast with large fillets at the ends of the ports and in the strengthening bars between the ports, also with the width of the ports 1-4 or 1-2 inch smaller than the finished size, and then machine it to the correct size, far less labor and time will be required to attain the same result.

In the item, *Piston Valves*, it is suggested that valves over 12 inches in diameter should have split rings. Experience has proved that spring rings on piston valves always cause the chambers to wear rapidly and out of round, destroying the precision of the cut-off and exhaust edges of the valves. Large valves should have a neatly fitted cast iron floating ring held in position by the follower, the ring being the full depth of the working face. Such a ring will be practically steam tight for a long time, and it is an easy matter to replace it by a new one when necessary.

Writing of *Eccentric Straps*, Mr. Kyles states that the top half of the eccentric strap liner often requires renewal, while the bottom half is very little worn, and suggests making the bottom half of the strap the same as the top to suit the foot of the eccentric rods, so that in case the top half is badly worn the strap simply requires to be turned upside down. There is no objection to this, but in a difficulty of this kind would it not be better to look a little more closely into the root of the trouble and install a balance piston, or bore out the chamber of the existing balance cylinder to give it more area so that the strain will not be entirely on the top half of the strap?

In discussing *Feed and Bilge Pump Plungers*, Mr. Kyles mentions a quick repair to the cast iron valve

chest of a bilge pump. He recommends that when the casting is so badly corroded that new valve seats cannot be introduced, a brass cage with ports be made to hold the suction and delivery valves, the cage to be set in the casting and held in place by the cover of the chest. This would only prolong the evil, for it is evident that the galvanic action by the contact of the brass cage would soon eat away all the iron around it and cause an excessive leak between the suction and delivery chamber. In designing cast iron bilge pump chests an extra allowance should always be made for the depth of the bearing of the seat, but the bearing alone should never be depended upon entirely for holding the seat. The best design of valve seat in new jobs, as well as in repairs, is to attach a flange or lugs so that it can be bolted fast to the chamber. The bolt holes in the flange or lugs, as well as the body of the studs, to be square to prevent the studs backing out. The studs should be of brass, care being taken when drilling and tapping for them not to go entirely through the division plate; the flange of the seat to be set down on red lead putty. This job will usually last as long as the chest.

In his comment on *Miter, Fiber and Check Valves*, Mr. Kyles calls attention to the difficulty in getting fiber valves to work efficiently in an air-pump. The question of the style of valves for an air-pump, especially those in the bucket, has given rise to considerable controversy. It is evident, however, that the old style of cast brass valves is rapidly going out of use, as in modern engines, with high piston speed, the bucket strikes the water at the bottom of the pump with such a velocity that each cast valve acts like a small battering ram against the head of its stud; and even if the studs are made of the best bronze, they cannot stand this treatment very long, and the air-pump chamber is soon filled with small bits of pounded brass. The Kinghorn valve, consisting of several discs of their bronze plate placed one on top of the other, seems to be the only style of valve which gives good satisfaction under all conditions, and can easily be applied to almost any pump which has been originally fitted with common valves or fiber valves.

In the item, *Copper Piping*, Mr. Kyles states that a 6-inch spigot on a copper pipe is useless, as the brazing only makes a thoroughly strong job for 2 inches of its length. He could well have made this statement in a much more emphatic manner, as, for instance, that the attempt to do anything of this kind ought to be forbidden by law. Any increase over 2 inches in the depth of the spigot of a brazed flange not only renders the brazing insecure, but is almost certain to burn part of the pipe. In the best brazing jobs the hole in the flange is filleted out on the joint side, and the pipe is thoroughly hammered into the hole and the edge hammered out bell-mouth shape into the fillet, so that the copper forms part of the joint face of the flange. This makes the pipe secure in case any expansion or contraction should ever strain it to the extent of parting it at the brazing, and, in fact, pipes have been connected up this way without any brazing at all.

Under the heading, *Propeller Shafting*, Mr. Kyles complains that many establishments are far too careless in fitting propeller hubs to shafts. It is by no means an easy thing to make an excellent fit with a large cast iron steel hub with a bore 45 to 55 inches long, where the material is so hard that the boring tool is dull by the time the cut is finished, or has to be sharpened before it finishes, so that the bore is not perfectly true. In cases of this kind where the error is very slight the best policy is to have the best fit at the large end of the taper, as the face of the nut will hold the after end.

The author further states that if the bore is badly pitted, or is a poor fit, a good job can be made by reboring it and pinning in a steel liner 3-8 inch thick, holding it in place with a collar. This may be all right where there is an excess of strength in the parts, but as loose or partially sheared keys are not uncommon, the 3-8 inch of material interposed between the two solid shearing edges will lessen the efficiency of the key, and deepening the keyway will only weaken the shaft. The safest way is to rebore the hub, taking as little metal out as possible, then face off the forward end equal to the extra amount it will go forward on the shaft, and recess the nut at the end of the shaft. If any of these conditions cannot be fulfilled it would be safer to condemn the hub.

In regard to the protection from galvanic action on a propeller shaft at the end of the brass liner, the practice of soldering or pouring a white metal ring between the ends of liners, or between the end of a liner and an iron ring shrunk on the shaft, has been condemned as inefficient. Compressed pure rubber is now used extensively. In some cases the soft rubber is wrapped on the shaft between the liners and heated with a blow-lamp, and latterly the entire shaft is put in a heater and the rubber vulcanized. This seems to answer the purpose very well, but is an ever recurring expense whenever it becomes necessary to strip it off in order to survey the shaft. The place where the after liner butts against the hub is usually protected by a soft rubber ring, which is compressed by an annular lipped ring bolted to the hub in two halves.

Too much cannot be said concerning the protection of all working parts from the corrosive action of sea water. Tallow seems to keep out sea water very well, and all steel rudder pintle nuts, propeller nuts and blade stud nuts should be surrounded by a metallic casing which has been poured full of molten tallow and the holes plugged. HENRY L. EBSEN.
New York.

The Hamburg-American Line has placed an order with the shipbuilders, Blohm & Voss, of Hamburg, for the construction of a new twin-screw steamer, which is intended to be the largest cargo carrier in the world. The dimensions of this vessel are: Length on the water line, 600 ft.; breadth, 66 ft.; depth, 42 ft. The total capacity for cargo, exclusive of coal and stores, will be 14,000 tons of 2,240 lbs., or about 20,000 tons of 40 cubic feet. There will also be accommodations for passengers, of which this steamer will be able to carry 300 in the first and 200 in the second cabin, and 600 steerage. The steamer will be driven by two sets of quadruple-expansion engines, of a power sufficient to maintain a sea speed of 14 knots. The new vessel will be fitted with numerous water-tight bulkheads and double sides, the inner and outer bottoms being carried up above the water line. This space will be minutely subdivided, and will add greatly to the safety of the vessel in case of collision. The claim is erroneously made by the company that this feature has never been introduced in the construction of a merchant vessel. Forty years ago a vessel named the Great Eastern was constructed in England on this principle of subdivision, and she made several trips to the port of New York, with passengers and cargo.

"Verbal Questions and Answers Given at the Board of Trade Examinations for Engineers" is the title of a little 140-page book just published by A. Ritchie Leask, 95 Minories, London, Eng. Taking it as a whole, this is one of the most complete, though concise, books of instruction of the sort we have any knowledge of. It is a thoroughly practical little book, plainly written and illustrated and is strictly up-to-date, which cannot be said for many of the elementary books of the kind on the market. The English selling price is 2s 6d, and the author's American agents are Spon & Chamberlain, 12 Cortlandt street, New York.

MISHAPS AT SEA.

Loss of the Atlantic Transport Line Steamship Mohegan off the Lizard, England.

On the night of October 14 the Atlantic Transport Line steamship Mohegan went on the rocks off the Lizard, in the English Channel. The vessel is probably a total loss, she having sunk in a short time, leaving only the tops of the masts and smoke pipe above water. Unfortunately the loss of the vessel was accompanied by a serious loss of life. There were on board about fifty-three passengers and ninety-one crew, and of these there were saved about eleven passengers and thirty-eight of the crew. Captain Griffiths, the commander, went down with his ship, and not any of the navigating officers was saved.

How the vessel could have got into the position where she was wrecked is inexplicable at this time. and in view of the loss of the deck officers it is doubtful if any court of inquiry can answer it. She was clearly off her course, in a channel which is well protected with powerful light houses, so that navigation there is largely a matter of pilotage. There are some strong currents there, but to a navigator experienced in those waters there does not seem to have been any special reason why he could not have kept off shore. When the mishap occurred the weather was clear, though a strong southeast wind was blowing. According to cabled reports of survivors, the captain and crew behaved like seamen after the vessel struck. Prompt efforts were made to load passengers into the boats and lower them over the sides. The ship sank quickly, however, and during this time her decks were inclined at a steep angle as she settled by the head, so that the difficulty of launching was greatly increased. Two life boats are said to have got away and subsequently been capsized because there were not enough sailors in each to properly man them.

So far as the passengers were concerned, there was no warning given of the mishap. Most of them were in the saloon at dinner when the Mohegan went on the rocks. Among those saved was John Hyslop, of New York, the widely known official measurer for the New York Yacht Club. A noble feature of this sad mishap was the work done by the lifeboat crew of Port Houstock, Cornwall, which put out and saved many lives. Some of the survivors who had on life belts were washed ashore and others were saved by holding on to pieces of wreckage.

The Mohegan was owned by the Atlantic Transport Line, sailing on the regular schedule between New York and London, under the British flag. She was west bound when lost. She was a new vessel, having been built recently as one of the fleet of the Wilsons-Furness-Leyland line and christened the Cleopatra. When the Atlantic Transport Line sold its fleet to the United States Government for use in transporting troops, it in turn purchased the entire fleet of the Wilsons-Furness-Leyland line, as readers of our August issue will recollect. As the Atlantic Transport Line's ships all have names commencing with the letter M, the new liners acquired were renamed the

ATLANTIC TRANSPORT LINE STEAMSHIP MOHEGAN, LOST OFF THE LIZARD ON THE NIGHT OF OCTOBER 14, 1898.

Mohegan, Marquette, Mesaba, Menominee and Manitou. The Mohegan (originally Cleopatra) was built by Earle's Shipbuilding Co., of Hull, and was launched April 6. She was the largest vessel ever built at that port and measured 482 ft. in length, 53 ft. in width and 34 ft. 6 in. in depth, molded to upper deck. Above this for the entire length there extended a shelter deck and above this again there was, amidships, a bridge deck 150 ft. long, on which there was a steel house 130 ft. long and 36 ft. wide. The top of the house was carried out to the sides and supported by stanchions. The platform thus formed served the purposes of carrying the boats and affording shade to the bridge deck, and at its forward end there was the pilot house and chart room. Still higher up there was a flying bridge over the wheel house. This entire superstructure was for the accommodation of the officers and passengers, and while it gave the ship a rather unsightly appearance, it was a comfortable resting place for the ocean traveler, especially in rough weather. There were berths for 120 saloon passengers, the only class this line carries, and the passengers' quarters were spacious and very handsomely fitted up. One hundred persons could sit down together at dinner in the main saloon. Forward there was the usual accommodation for the crew and quarters for cattlemen, the vessel being fitted to carry a great many head of cattle under the shelter deck.

As the vessel was not intended for high speed, her engines were of 5,000 I.H.P., capable of driving her at the rate of 15 knots at sea. She was a single-screw vessel, and the engines were of the three-crank triple-expansion type, taking steam at 200 lbs. pressure from two double-ended and one single-ended boilers, fitted with Howden draft.

Her general appearance when at sea is shown in the drawing (port bow) made by our artist. She was a well-fitted and found vessel, and rated in the highest class at Lloyds. She had begun her second voyage only when she was wrecked.

The loss of the S.S. Maracaibo, of the Red D Line, was reported last month. She was engaged in the trade between Venezuelan ports and the Windward Islands. She sailed from New York, October 4, for Ponce, Maracaibo and Curacoa, with a general cargo and passengers. She called at Ponce and Curacoa and landed her passengers and sailed for Maracaibo, October 13. She went ashore on Paraguana Peninsula, Venezuela. Captain Reitt and the crew were saved. The Maracaibo was built at Philadelphia, at Hillman's yard, in 1889. Her dimensions were: Length, 231 ft; beam, 43 ft., and depth, 13 ft. 6 in. Her gross tonnage was 1,262 tons. She was schooner rigged and was fitted with triple-expansion engines.

The British ship Blengfell, with a cargo of case oil from New York, took fire on the morning of October 7, when about four miles off Margate, on the southeast coast of England, and was a total loss. The fire followed an explosion, which blew out the stern of the ship, and probably killed the captain and pilot and two officers, who were reported missing. A tug was alongside at the time, making ready to take the ship in tow, and she rescued twelve of the crew. The Blengfell was a three-masted iron ship of 1,210 tons, built in 1876, and owned in Liverpool. Her dimensions were: Length, 234 ft. 4 in.; beam, 35 ft. 2 in., and depth, 21 ft. 1 in. She sailed from New York September 19 with a cargo of 329,300 gallons of case oil, consigned to London parties. Balfour, Williams & Co. were her agents in New York.

George Clarke, formerly a member of the executive staff at Newport News Shipyard, has been appointed consulting engineer to the Quartermaster's Department of the U. S. Army, in the transportation department, with headquarters at New York.

EDUCATIONAL DEPARTMENT.

CALCULATIONS FOR ENGINEERS—AN AID TO CANDIDATES FOR MARINE PAPERS—II.

BY DR. WILLIAM FREDERICK DURAND.

§4. COMPOUND NUMBERS.

Weights and Measures.

[1] LONG OR LINEAR MEASURE.

Inches.	Feet.	Yards.	Rods.	Furlongs	Miles.	Meters.
1	.0833	.0278	.01515	.000126	.000016	.0254
12	= 1	.333	.0606	.00152	.000189	.305
36	3	= 1	.182	.00455	.000568	.914
198	16½	5½	= 1	.025	.00313	5.029
7920	660	220	40	=1	.125	201.166
63360	5280	1760	320	8	=1	1609.3
39.371	3.281	1.094	.199	.00497	.000621	= 1

SPECIAL MEASURES.

6	feet	= 1 fathom.
120	fathoms	= 1 cable's length.
6080.27	feet	= 1 nautical mile (United States).
6080	feet	= 1 nautical mile (British).
3	nautical miles	= 1 marine league.

[2] AVOIRDUPOIS WEIGHT OR MEASURE.

Drams.	Ounces.	Pounds.	Tons.		Kilos.
			Long or British.	Short or Legal.	
1	.0625	.0039	.....	.....	.....
16	= 1	.0625	.....	.....	.02835
256	16	= 1	.000446	.0005	.4536
573440	35840	2240	= 1	1.12	1016
512000	32000	2000	.89	= 1	907
564.38	35.27	2.2046	.000984	.001102	= 1

[3] SQUARE MEASURE.

Square Inches.	Square Feet.	Square Yards.	Square Meters.
1	.00694	.000772	.000645
144	=	.1111	.0929
1296	9	= 1	.8360
1550	10.765	1.196	= 1

[4] CUBIC OR VOLUME MEASURE.

Cubic Inches.	Cubic Feet.	Cubic Yards.	Cubic Meters.
1	.0005788	.....	.....
1728	= 1	.037	.0283
46656	27	= 1	.7645
61033	35.32	1.308	= 1

[5] LIQUID MEASURE.

Cubic Inches.	Gills.	Pints.	Quarts.	Gallons.		Barrels.
				U. S.	British.	
1	.1154	.02885	.0144	.00433	.00361	.....
8.665	=1	.25	.125	.03125	.3125	.....
34.659	4	=1	.50	.125	.125	.....
69.318	8	2	=1	.25	.25	.....
231	32	8	4	=1	.833	.003175
277.274	32	8	4	1.2	=1	.003175
....	1008	252	126	31½	31½	=1

[7] SHIPPING MEASURE.

1 register ton	=	100 cubic feet.
1 United States shipping ton	=	40 cubic feet or 32.14 United States bushels.
1 British shipping ton	=	42 cubic feet or 32.72 imperial bushels.

[6] Dry Measure.

Cubic Inches	Pints.	Quarts.	Pecks.	Bushels.
1	.02976	.01488	.00186	.0004641
33.6	=1	.5	.0625	.015625
67.2	2	=1	.125	.03125
537.6	16	8	=1	.25
2150.42	64	32	4	=1

[8] **The Metric System of Weights and Measures.**

Measures of Length.

10 millimeters (mm)	= 1 centimeter	cm.
10 centimeters	= 1 decimeter	dm.
10 decimeters	= 1 meter	m.
10 meters	= 1 dekameter	Dm.
10 dekameters	= 1 hektometer	Hm.
10 hektometers	= 1 kilometer	Km.

Measures of Surface (Not Land).

100 square millimeters (mm^2)	= 1 square centimeter	cm^2.
100 square centimeters	= 1 square decimeter	dm^2.
100 square decimeters	= 1 square meter	m^2.

Measures of Volume.

1000 cubic millimeters (mm^3)	= 1 cubic centimeter	cm^3.
1000 cubic centimeters	= 1 cubic decimeter	dm^3.
1000 cubic decimeters	= 1 cubic meter	m^3.

Measures of Capacity.

10 milliliters (ml)	= 1 centiliter	cl.
10 centiliters	= 1 deciliter	dl.
10 deciliters	= 1 liter	l.
10 liters	= 1 dekaliter	Dl.
10 dekaliters	= 1 hektoliter	Hl.
10 hektoliters	= 1 kiloliter	Kl.

Note.—The liter is equal to the volume occupied by 1 cubic decimeter of pure distilled water at its temperature of maximum density, or 39.2° F.

Measures of Weight.

10 milligrams (mg)	= 1 centigram	cg.
10 centigrams	= 1 decigram	dg.
10 decigrams	= 1 gram	g.
10 grams	= 1 dekagram	Dg.
10 dekagrams	= 1 hektogram	Hg.
10 hektograms	= 1 kilogram	Kg.
1000 kilograms	= 1 ton	T.

Note.—The gram is the weight of 1 cubic centimeter of pure distilled water at a temperature of 39.2° F.; the kilogram is the weight of 1 liter of water; the ton is the weight of 1 cubic meter of water.

[9] **Conversion Tables.**

English Measures into Metric.

English.	Inches to Millimeters.	Feet to Meters.	Pounds to Kilos.	Gallons to Liters.
1	25.4001	.304801	.45359	3.78544
2	50.8001	.609601	.90719	7.57088
3	76.2002	.914402	1.36078	11.35632
4	101.6002	1.219202	1.81437	15.14176
5	127.0003	1.524003	2.26796	18.92720
6	152.4003	1.828804	2.72156	22.71264
7	177.8004	2.133604	3.17515	26.49808
8	203.2004	2.438405	3.62874	30.28352
9	228.6005	2.743205	4.08233	34.06896

Metric Measures into English.

Metric.	Meters to Inches.	Meters to Feet.	Kilos to Pounds.	Liters to Gallons.
1	39.3700	3.28083	2.20462	.26417
2	78.7400	6.56167	4.40924	.52834
3	118.1100	9.84250	6.61386	.79251
4	157.4800	13.12333	8.81849	1.05668
5	196.8500	16.40417	11.02311	1.32085
6	236.2200	19.68500	13.22773	1.58502
7	275.5900	22.96583	15 43235	1.84919
8	314.9600	26.24667	17.63697	2.11336
9	354.3300	29.52750	19.84159	2.37753

Use of the Conversion Tables.

Example: Change 243.6 feet into meters.

$$243.6 = 200 + 40 + 3 + .6.$$

These parts separately may all be directly converted from the table by an appropriate use of the decimal point. Thus, keeping simply three places of decimals:

200	feet =	60.960 meters.
40	feet =	12.192 meters.
3	feet =	.914 meters.
.6	feet =	.183 meters.
Hence, adding: 243.6 feet =		74.249 meters.

Other examples may be solved in an entirely similar manner.

[10] **Reduction of Compound Numbers.**

Example—(1) Reduce 7 miles, 12 rods, 10 feet to feet. We may proceed in two ways: (a) We may reduce the rods to feet and add in the 10 thus: $12 \times 16\frac{1}{2} + 10 = 198 + 10 = 208$. Then reduce the miles to feet and add in the 208 thus: $7 \times 5{,}280 + 208 = 36{,}960 + 208 = 37{,}168$ feet; or (b) We may reduce the miles to rods and add in the 12 thus: $7 \times 320 + 12 = 2{,}240 + 12 = 2{,}252$. Then reduce the rods to feet and add in the 10 thus: $2{,}252 \times 16\frac{1}{2} + 10 = 37{,}158 + 10 = 37{,}168$ feet. The result will, of course, be the same in either case. The factors for making the reductions may be either taken from the tables of Sec. 4 or readily found by separate computation.

Example—(2) Reduce 37,168 feet to miles, rods and feet.

This is the inverse of the above and may likewise be solved in two ways: (a) We may reduce the feet to miles with feet as a remainder, thus: $37{,}168 \div 5{,}280 = 7$ miles and 208 feet remainder. Then reduce the feet to rods with feet again as a remainder, thus: $208 \div 16\frac{1}{2} = 12$ rods and 10 feet remainder. Hence, 37,168 feet = 7 miles, 12 rods, 10 feet; or (b) We may reduce the feet to rods with feet as a remainder, thus: $37{,}168 \div 16\frac{1}{2} = 2{,}252$ rods and 10 feet remainder. Then reduce the rods to miles with rods as a remainder, thus: $2{,}252 \div 320 = 7$ miles and 12 rods remainder. We have, therefore, as before, 37,168 feet = 7 miles, 12 rods, 10 feet.

These examples will sufficiently illustrate the mode of procedure so that all similar problems may be readily solved.

Addition, Subtraction, Multiplication and Division of Compound Numbers.

[11] Addition of Compound Numbers.

Example—Add the following:

16 miles	43 rods	12 feet
21 miles	308 rods	9 feet
7 miles	318 rods	$7\frac{1}{2}$ feet
44 miles	669 rods	$28\frac{1}{2}$ feet
or 46 miles	30 rods	12 feet

The columns are added as in whole numbers and the sums are brought down. This gives a correct result, but it is not in its simplest form, since $28\frac{1}{2}$ feet are more than 1 rod, and 669 rods are more than 1 mile. We therefore reduce the feet to rods, giving 1 rod and 12 feet, and then carry the 1 to the column of rods, giving 670. We then reduce the rods to miles, giving 2 miles and 30 rods, and carry the 2 to the column of miles, thus giving the final result as stated in the second line of the answer.

[12] Subtraction of Compound Numbers.

Example—In the following subtract the lower from the upper:

36 miles	18 rods	14 feet
21 miles	43 rods	6 feet

In the column of rods, the 43 being greater than the 18, we cannot subtract directly, and therefore borrow 1 mile or 320 rods from the 36 miles, thus putting the minuend into the form as follows:

35 miles	338 rods	14 feet
21 miles	43 rods	6 feet
14 miles	295 rods	8 feet

We may then subtract each column as in whole num-

bers, thus giving the result as shown. In the actual operation the borrowing may be done mentally, thus making it unnecessary to rewrite the minuend as shown.

[13] Multiplication of Compound Numbers.

Example—Mutiply 14 miles, 276 rods, 12 feet by 5.

Operation:

14 miles	276 rods	12 feet
		5 feet
70 miles	1,380 rods	60 feet
74 miles	103 rods	10½ feet

We first multiply each term by the multiplier 5 and obtain the result entered in the first line below. This is correct, but not in its simplest form, since 60 feet are more than 1 rod and 1,380 rods more than 1 mile. We therefore reduce the feet to rods, giving 3 rods and 10½ feet, and carry the 3 to the column of rods, giving 1,383. We then reduce the rods to miles, giving 4 miles and 103 rods and carry the 4 to the column of miles, giving the final result as stated in the second line of the answer.

[14] Division of Compound Numbers.

Example—Divide 142 miles, 296 rods, 15 feet by 6.

Operation:

6)142 miles	296 rods	15 feet
23⅔ miles	49⅓ rods	2½ feet

We first divide each term separately by the divisor 6 and obtain the result as written below the line. This is correct, but not in its simplest form, since ⅔ miles may be reduced to rods and feet, and ⅓ rod may be reduced to feet. We therefore simplify as follows:

23	49	2½
	213	11
23	262	13½

Since there are 320 rods in 1 mile, we have ⅔ miles = ⅔ × 320 rods = 213⅓ rods. We set down the 213 in the column of rods, and, adding the ⅓ to the other ⅓ belonging with the 49, we have ⅔ rod in addition. Since there are 16½ feet in 1 rod, we have ⅔ rod = ⅔ × 16½ = 11 feet. This we enter in the column of feet and add, giving the final result as shown.

These examples will sufficiently illustrate the principles involved in the addition, subtraction, multiplication and division of compound numbers so that all similar problems may be readily solved.

Addition, Subtraction and Multiplication of Duo-decimals.

[5] Duodecimals. It is often necessary to determine areas or volumes, the dimensions of which are given in feet and inches. To this end we may either reduce the dimensions to feet and decimals, or treat them directly by the method of *duo-decimals*. In this system of expressing numbers, use is made of a series of numerical units, each one-twelfth of the unit of next higher order. The fundamental unit will be either the linear foot, the square foot or the cubic foot, according to the geometrical nature of the quantity to be expressed. Lengths are thus expressed in feet, inches and twelfths; or, as they are termed, feet, primes and seconds. Similarly areas are expressed in square feet, primes and seconds, and volumes in cubic feet, primes and seconds, the prime in each case being one-twelfth the foot, and the second one-twelfth the prime.

Duo-decimals should be written with a series of accents thus: 6° — 7′ — 10″. The ° stands for the fundamental unit, the foot; which may be a length, an area or a volume, according to the problem; the single accent ′ stands for the prime, and the double accent ″ for the second.[4] Thus, if the unit were a foot of length, the above expression would mean 6 feet, 7 primes or inches, and 10 seconds or $\frac{10}{12}$ inch. If the unit were a square foot it would mean 6 square feet, $\frac{7}{12}$ of a square foot and $\frac{10}{12}$ of $\frac{1}{12}$, or $\frac{10}{144}$ of a square foot. Hence, in all, 6 square feet and 94 square inches. If the unit were a cubic foot it would mean 6 cubic feet, $\frac{7}{12}$ of a cubic foot and $\frac{10}{12}$ of $\frac{1}{12}$, or $\frac{10}{144}$ of a cubic foot Hence, in all, 6 cubic feet and 1,128 cubic inches.

[4] Care must be taken to avoid confusion between this method of writing duo-decimals and the common method of expressing feet and inches by one and two accents.

Addition of Duo-decimals. The addition of duo-decimals is carried on exactly as in compound numbers, quantities of the same order being written under each other and their sums, where necessary, reduced to units of higher order by division by 12.

Example—Add

17° — 8′ — 10″	
14° — 2′ — 9″	
7° — 1′ — 7″	
Sum: 39° — 1′ — 2″	

Subtraction of Duo-decimals. The subtraction of duo-decimals is carried on exactly as in compound numbers, quantities of the same order being written under each other and units of a higher order being borrowed where necessary.

Multiplication of Duo-decimals. This operation, which is the one of greatest importance in the treatment of duo-decimals, is carried on according to the following:

Rule—Set down the two quantities, with terms of the same order under each other. Multiply each term of the multiplicand by each term of the multiplier. The order of any such product will be determined by adding the indices of the two terms used. If the product is greater than 12, reduce to the next higher order by dividing by 12, and set down the quotient and remainder in their proper columns. Proceed in this way, taking care in the product to set down terms of the same order under each other. Then add and reduce where necessary to the higher order by dividing by 12.

Example—Multiply together:

6° — 10′ — 4″			‴
4° — 8′			
4	6	2	8
3	1	8	
24	4	4	
31°	11′	2″	8‴

We have first 8′ × 4″ = 32‴ = 2″ — 8‴, which is set down. We have next 8′ × 10′ = 80″ = 6′ — 8″, which is set down. We have next 8′ × 6° = 48′ = 4°, which is set down. In the same way we use the other term of the multiplier, 4°, and then add and reduce the columns as shown.

For purposes with which the marine engineer is concerned, feet and inches are alone involved, and operations with duo-decimals are correspondingly simplified.

Examples—(1) Find the area of a boiler plate 12° — 5′ long by 6° — 7′ wide.

Multiplying as before, we find for the product 81° — 8′ — 11″, or taking the result to the nearest prime, 81° — 9′ or 81$\frac{9}{12}$ square feet or 81 square feet — 108 square inches.

(2) Find the volume of a bunker 26° — 4′ by 9° — 7′ by 7° — 10′.

Taking first the product of 26° — 4′ by 9° — 7′, we have 252° — 4′ — 4″. Then multiplying this by 7° — 10′ we have 1,976° — 10′ — 11″ — 4‴, or taking the result to the nearest prime, 1,976° — 11′, or 1,976$\frac{11}{12}$ cubic feet or 1,976 cubic feet — 1,584 cubic inches.

§ 6. RATIO AND PROPORTION.

The ratio between two numbers is simply their numerical relationship expressed as the quotient of the first divided by the second. Thus the ratio of 6 to 3 is 2; of 1.2 to 3 is .4; of 4 to 5 is .8, etc. Ratio is often expressed by the sign : which is simply an abbreviation of the sign of division ÷. Thus 6 : 3 = 2; 1.2 : 3 = .4, etc. Ratio is also expressed by the sign of division or in the form of a fraction. Thus

6 : 3 or 6 ÷ 3 or $\frac{6}{3}$ = 2
1.2 : 3 or 1.2 ÷ 3 or $\frac{1.2}{3}$ = .4, etc.

Simple Proportion.

[1] A *proportion* is a statement of the equality of two ratios. The equality is commonly expressed by the symbol : :

Thus. $6 : 3 : : 4 : 2$.....(1)

A proportion may also be written in other ways, as follows:

$$6 : 3 = 4 . 2 \text{.....(2)}$$
$$\tfrac{6}{3} = \tfrac{4}{2} \text{.....(3)}$$

A proportion always contains four terms, two for each ratio, and when written as in (1) and (2) the first and last terms are called *extremes* and the second and third are called *means*. To solve a proportion three terms must always be known and then the remaining term can always be found. From the nature of a proportion it follows that the product of the extremes must equal the product of the means, and this gives the usual rule for solution as follows:

Rule—If the unknown term is an extreme, multiply together the two means and divide by the other extreme. If the unknown term is a mean, multiply together the two extremes and divide by the other mean. In either case the quotient will give the remaining term desired.

In a proportion two of the terms always relate to one kind of quantity, while the other two relate to another. Likewise two of the terms always relate to one set of conditions, while the other two relate to another set. In problems to be solved by proportion, therefore, where three terms must be given, two terms will be of one kind and the remaining term will be of another and of the same kind as the answer. Also two terms will relate to the given set of conditions, and the remaining term to the set involving the unknown term or answer.

Again, proportions are of two kinds, *direct* and *inverse*. In a direct proportion the relation between the two quantities different in kind is such that both increase or decrease together. In an inverse proportion the relation between these two quantities is such that one increases as the other decreases. Thus if the question involves the relation between distance and speed, the time being the same, the proportion is direct, because, for a given time, the more speed the more distance, or the more distance the more speed. On the other hand, if the question involves the relation between speed and time for a given distance, the proportion is inverse, because, for a given distance, the more speed the less time, or the more time the less speed, and *vice versa*. Our general knowledge of the relation between the quantities involved will thus enable us to determine whether the proportion will be direct or inverse.

Example of a direct proportion:

If a ship steams 1,400 miles in 5 days, how far will she steam in 8 days at the same rate?

Here two of the given terms are days and one is miles, being of the same character as the answer desired. Also two relate to one performance or set of conditions (1,400 miles in 5 days) while the other relates to another set (the desired performance in 8 days). Our right to solve this example by direct proportion lies in the fact that the relation between the 5 days and 1,400 miles must be the same as that between the 8 days and the distance desired, and hence there must be an equality in the ratios showing these relations, and similarly for problems of like character.

A simple *direct* proportion, like that involved in the example above, may be stated in various ways, of which two will serve our present purpose.

(a) $\overset{(2)}{\text{Ans.}}$ (miles) : $\overset{(2)}{8}$ (days) : : $\overset{(1)}{1400}$ (miles) : $\overset{(1)}{5}$ (days)

(b) $\overset{(2)}{\text{Ans.}}$ (miles) : $\overset{(1)}{1400}$ (miles) : : $\overset{(2)}{8}$ (days) : $\overset{(1)}{5}$ (days)

The numbers in ( ) relate to the two sets of conditions, the first being the set given, and the second being the set for which the distance is desired. It is thus seen that the proportion may be stated as in (a), with each set of conditions forming a ratio, the items of the proportion alternating: miles, days, miles, days: or it may be stated as in (b), with the set of conditions alternating 2d, 1st, 2d, 1st, the two items of each ratio being the same.

Example of an inverse proportion:

If a ship at 10 knots does a certain trip in 5 days, how many days will be required at 12 knots?

The relation between time and speed, as we know, is such that, for a given distance, the more speed the less time, or the less speed the more time. The time is, therefore, said to be in such case *inversely* proportional to the speed. That is, for example, if the speed is *doubled* the time will be *halved*, etc.

An inverse proportion may be stated as follows:

(c) $\overset{(2)}{\text{Ans.}}$ (days) : $\overset{(1)}{10}$ (knots) : : $\overset{(1)}{5}$ (days) : $\overset{(2)}{12}$ (knots)

(d) $\overset{(2)}{\text{Ans.}}$ (days) : $\overset{(1)}{5}$ (days) : : $\overset{(1)}{10}$ (knots) : $\overset{(2)}{12}$ (knots)

The difference between these methods of statement and those above for direct proportion will be readily seen by comparison.

As another general way of stating a proportion whether direct or inverse we may proceed as follows:

Put the *answer*, or letter representing it, for the first term, and the other quantity of the same kind for the second term. Then, according as the first term or answer should be greater or less than the second term, write the third and fourth terms in the same order. That is if the relation of the quantities is such that the *answer* should be greater than the second term, write the third and fourth terms in the order *greater — lesser:* or if the *answer* should be less than the second term, write the third and fourth terms in the order *lesser — greater.*

After having become familiar with the methods of stating a proportion, the names of the quantities and the numbers denoting the sets of conditions may, of course, be omitted, and we should have instead of (a) and (b)

$$\text{Ans.} : 8 : : 1400 : 5$$
$$\text{Ans.} : 1400 : : 8 : 5$$

Solving either of these according to the rule given, we have:

$$\text{Distance} = 8 \times 1400 \div 5 = 2240 \text{ ans.}$$

Likewise instead of (c) and (d) we should have:

$$\text{Ans.} : 10 : : 5 : 12$$
$$\text{Ans.} : 5 : : 10 : 12$$

Solving either of these we have:

$$\text{Days} = 5 \times 10 \div 12 = 50 \div 12 = 4\tfrac{1}{6} \text{ Ans.}$$

OBITUARY.

John H. Dialogue, the shipbuilder, of Camden, N. J., died at his residence, Sunday, October 23, after several weeks' illness.

John Murray Forbes died at his residence in Milton, Mass., October 11, at the advanced age of 85 years. For many years he had engaged in the shipping business, although more recently he had given much attention to railroad investments. At various times he was the owner of both steam and sail yachts.

Chief Engineer Philip Inch, U.S.N., who was retired last August, died suddenly at Dr. Strong's sanitarium, Saratoga, October 19, from neuralgia of the heart. Mr. Inch was 62 years old. He was appointed to the Navy from the District of Columbia in 1857, and entered the service as third assistant engineer of the frigate Roanoke. In 1863 he was promoted to chief engineer. From 1881 to 1884 he was fleet engineer of the Asiatic station. He was with the Bureau of Steam Engineering in 1884-5, and was also a member of the Board of Inspection.

THE ART OF MAKING MECHANICAL SKETCHES —FOR MARINE ENGINEERS.—V.

BY PROF. C. W. MAC CORD.

In the preceding article, it will be recollected, were explained the processes by which, from the drawings of an object in its most simple position in relation to the paper, we are enabled to construct the correct representation of the same object in the most complicated position in which it can be placed. For the sake of simplicity and uniformity, the rectangular prism was selected as the object; and it was shown that the projections of its upper and lower bases would in all cases be either rectangular, or parallelograms with acute and obtuse angles. But the original bases being rectangles, a circle could always be circumscribed about either, hence the corners of the bases would be points in those circles; and it was pointed out that by doubling the numbers of the sides of the bases, any desired number of points in the circumscribing circles might be found in any one of the projections, and the projections of the circle thus obtained.

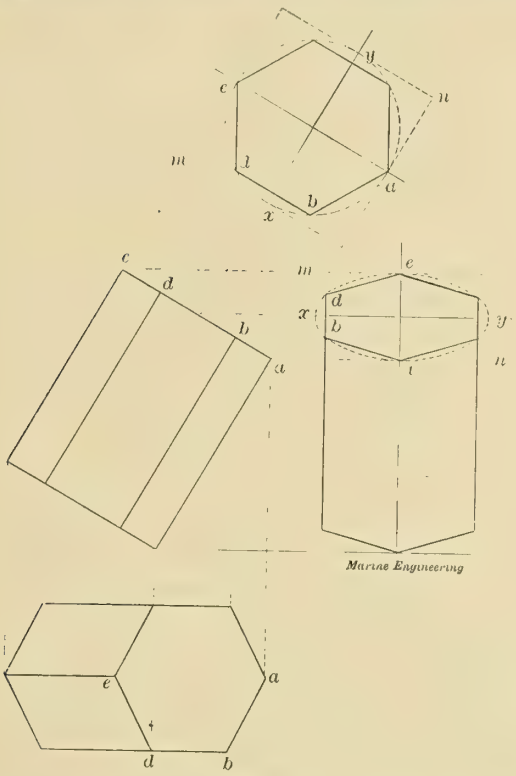


Fig. 22.

Now if the base of the prism be any regular polygon whatever, it can also be circumscribed by a circle, and the angles of the polygon will in like manner be points in the circumference, in whatever position the object be placed. In Fig. 22 are shown three views of a hexagonal prism, inclined to the right, the true form and size of its base being shown in the direct top view above. The corresponding points in the different views being similarly lettered, the construction requires no explanation. Since the circle in the direct end view passes through the points *a*, *b*, *d*, etc., it must in the side view also be represented by a curve passing through those points. By doubling the number of sides of the polygon, we could determine twice as many points in the curve, and so on as far as one chose to carry the process of subdivision.

This, obviously, amounts to nothing more than finding the projections in the right-hand view of so many points in the direct end view; and if our object be to represent the circle, it would make no difference whether those points should be actually equidistant or not. We might then take any points at pleasure in the original circle, and by the principles already explained determine their projections in any position of the cylinder which circumscribes the prism. And if the operations be accurately performed, the result would be correct, whether the operator knew what the resulting curve should be, or not.

This, however, would involve considerable work, even when, as in this case, but one of the three

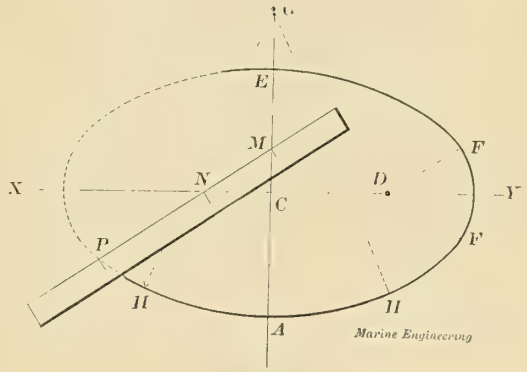


Fig. 23.

rotations has been performed; and it is clear that if the other two be superadded, this method would be exceedingly tedious.

A much more expeditious method is to make use of a circumscribing figure instead of an inscribed one. Thus, drawing the square *m n* in the direct top view, this will appear in the right-hand view as the rectangle *m n*, of which two sides are equal and parallel to *a e*, the other two to *x y*; and the sides of the original square being tangent to the circle, the sides of the square will be tangent to the curve, which is of itself an advantage, as indicating the direction of the curve at the points of contact.

Now, we may avail ourselves of the fact that any inclined projection of a circle is an ellipse, and having the major axis *x y* and the minor axis *a e*, we can proceed to draw the curve without finding the projections of any more points. And the ellipse is

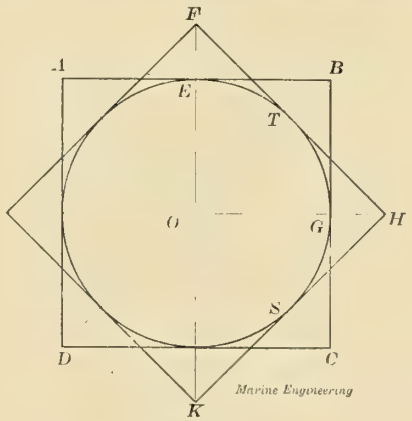


Fig. 24.

so frequently met with in mechanical drawing, not only in the representation of inclined cylinders, but in constructing the sections of both cones and cylinders by inclined planes, that we introduce here, for the benefit of any who may not be familiar with them, one or two ready methods of laying out this curve.

When the axes are given, as *X Y*, *A E*, in Fig. 23; on

the straight edge of a slip of paper set off $P\ M$ equal to the semi-major axis $C\ Y$, and $P\ N$ equal to the semi-minor axis $C\ A$. Then move the slip around, keeping the point M always on the line of the minor axis, and N always on the line of the major axis; the point P will then always lie upon the ellipse.

In drawing the curve, a center G upon $A\ E$ produced, can be found by trial and error, from which a circular arc as $H\ A\ H$ can be drawn, which will sensibly coincide with that part of the ellipse. In like manner a center D upon the other axis is found,

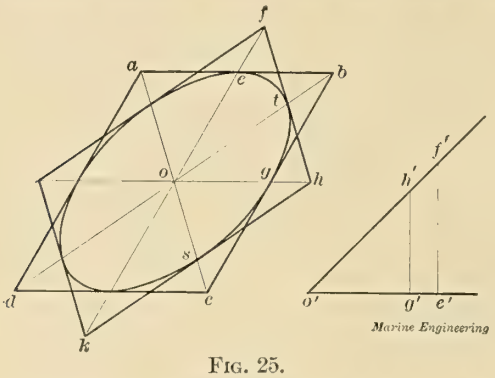


FIG. 25.

with which the approximating arc $F\ Y\ F$ is drawn, thus leaving but a short portion to be finished by the aid of the curved rulers.

But it may be required to draw the cylinder after more than one rotation has been performed, in which case the square circumscribing its base will no longer be a rectangle. It will, however, be a parallelogram, no matter what may be the original position of the square.

A simple process may be used in this case, the first step in which is to suppose the circle to be circumscribed by two squares, $A\ C$, $F\ K$, as in Fig. 24, the sides of each being parallel to the diagonal of the other. In the required position, each of these squares will be represented by a parallelogram, as shown in Fig. 25, and the sides of each will still be parallel to the diagonals of the other, as in the case of the original squares.

Moreover, the points T, G, S, etc., in which the side of either square cuts the diagonal of the other,

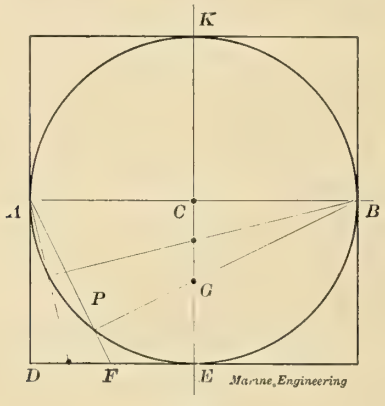


FIG. 26.

are points of tangency; so that if the projections of these squares, as $a\ c$, $f\ k$, be determined, and the diagonals drawn, we shall have eight points in the ellipse as e, t, g, s, etc., and what is of more importance, the tangents at those points, which would enable us to sketch in the curve with a fair approach to accuracy.

It seems hardly possible to attain our result with less trouble than is involved in finding the projection, as $a\ c$, of one of the supposed squares, $A\ C$. But, once that is done, it is not necessary to draw the other square $F\ K$, nor to determine the projection of its corresponding parallelogram $f\ k$.

Because $O\ G$, $O\ H$, being equally foreshortened, would be represented by $o\ g$, $o\ h$, having the same ratio, which is that of the side of a square to its diagonal. Supposing now the parallelogram $a\ c$ to have been determined (as the projection of the square $A\ C$ of Fig. 24), thus determining $o\ g$; then in the small auxiliary diagram draw $o'\ x$ and $o'\ y$, making with each other an angle of 45°; from o' set off on $o'\ x$, a distance $o'\ g'$ equal to $o\ g$, and at g' draw a perpendicular to $o'\ x$, cutting $o'\ y$ in h'; also we may make $o'\ e' = o\ e$, and erect a perpendicular to determine $o'\ f'$. Then setting off $o\ h$, $o\ f$, respectively equal to $o'\ h'$, $o'\ f'$, we may complete the projection of the second square without drawing the original.

Thus we still have eight points in the required curve, and also, as before, the tangents at those points; and the guidance thus furnished is sufficient to enable one, with very little practice, to sketch in the curve with considerable precision.

But if the drawing be on a large scale, the need of other points may be felt; but we have not now the axes of the ellipse, nor is there any ready means of determining them without first drawing the curve itself, so that the method of the paper trammel cannot be applied.

In this case, resort may be had to another process, the principle of which will be clear by the aid

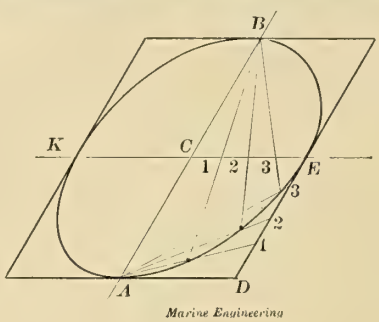


FIG. 27.

of Fig. 26. Having given the circle with its circumscribing square; from one extremity A of a diameter, draw a line through any point P on the circumference, produce it to cut the side of the square in F, and join $P\ B$, cutting $C\ E$, in G, then $B\ C$ is perpendicular to $A\ D$, $C\ G$ to $D\ F$, and $B\ G$ to $A\ F$, therefore the triangles $B\ G\ C$, $A\ F\ D$, are similar, and $D\ F$: $A\ D$: : $C\ G$: $C\ B$. Or, since $A\ D = D\ E$, and $C\ B = C\ E$, we have $D\ F : D\ E$: : $C\ G : C\ E$. Had we reversed the process, for instance bisecting $D\ E$ at F, and $C\ E$ at G, then drawing $B\ G$ through G and producing it to cut $A\ F$, it follows that the point of intersection P must lie on the circumference; by bisecting $D\ F$ and $C\ G$, another point on the circumference could be found in a similar manner, and such a subdivision may be carried as far as we choose.

Now when this square is projected in an oblique position, all the subdivisions on $C\ E$ will be foreshortened in the same proportion; and so will those on $D\ E$, though those two proportions may not be the same.

Supposing then that this square is finally projected as the parallelogram in Fig. 27; divide $C\ E$ into any number of equal parts, and $D\ E$ into the same number; from A draw lines to the points of division, 1, 2, 3, on $D\ E$, and from B draw lines through the points 1, 2, 3, on $C\ E$, producing them to cut the first series, in their order; then the points of intersection will lie upon the ellipse, which is the foreshortened representation of the original circle.

ENGINEERS' DICTIONARY—XI.

Connecting-Rod.—That part of an engine which connects at one end with the crosshead and at the other with the crank. One end thus moves in a vertical straight line path, while the other travels in a circle. It is thus the member which directly effects the transformation of the straight-line motion of the piston and crosshead into the circular motion of the crank. Marine connecting rods differ chiefly in the

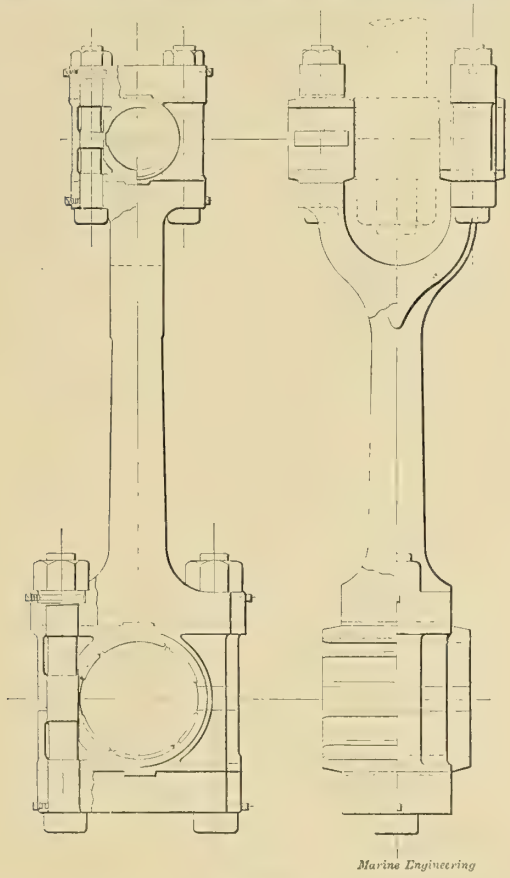


FIG. 35.

mode of attachment to the crosshead. In one of the two ordinary types, as shown in Fig. 34, the pin is secured fast in the upper forked end of the rod, its bearing being provided in the crosshead. With the other type shown in Fig. 35 the pins are two in number and are fast in the crosshead or forged with it, their bearings being provided in the upper forked ends of the connecting rod.

Consumption of Steam.—A term used to denote the number of pounds of steam required to develop one indicated horse power for a period of one hour. With good triple-expansion marine engines the figure is usually not far from 15. With lower pressure and with compound engines it will rise to 17 or 18, with simple condensing engines to 25 or 30, and with simple non-condensing to 30 or 40 or more. It should not be forgotten that the steam engine is really a *heat* engine, and hence the number of pounds of steam required is not an exact measure of the economy of the engine, since the formation of one pound of steam may require more or less heat depending on its pressure, temperature of the feed, and quality of the steam. The steam consumption answers, however, for purposes of approximate estimate, and is much used in the absence of more definite information relating to the actual amount of heat required.

Corrugated Furnace.—A form of boiler furnace in which the metal is disposed in corrugations as shown in Fig. 36. It is known that the strength of a cylindrical shell exposed to pressure on the outer or convex side depends on the length and is less as the length is greater. It may be considered that the corrugations of a furnace are equivalent to its subdivision into a large number of short lengths represented by the hollows, each supported by the convex intermediate ridges. This results in a shortening of the length as related to strength, and hence in an in-

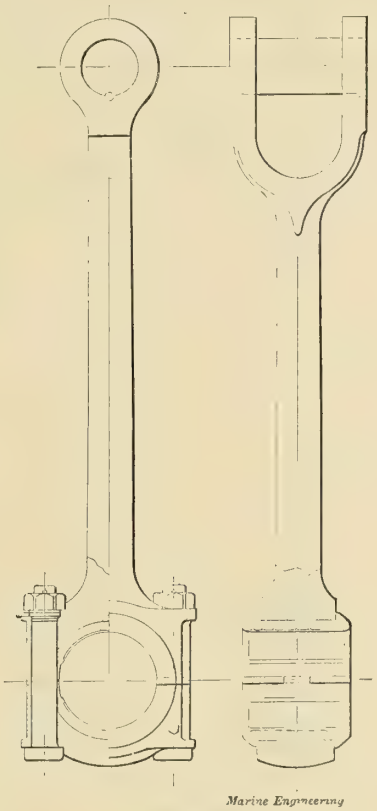


FIG. 34.

crease of strength for a given thickness of metal. The corrugated furnace has also much greater longitudinal elasticity than the plain form, and is thus the better able to withstand expansion and contraction caused by extreme changes of temperature. There are various styles of corrugation, those most com-

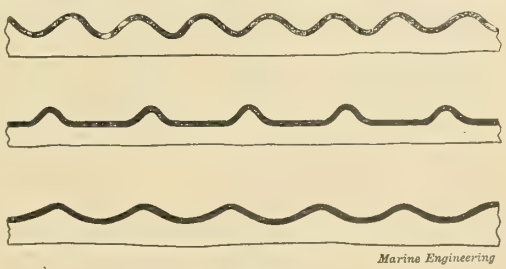


FIG. 36.

monly used being the "Fox," "Morison" and "Purves," as shown in Fig. 36, in the order named, commencing at the top. Corrugated furnaces of one type or another are used almost entirely in present engineering practice.

Counter.—An apparatus used to mechanically register the revolutions of the engine.

Counter-bore.—A space at the end of a cylinder of diameter slightly greater than the bore, and so placed that the piston shall slightly overrun its edge, and thus in case of wear avoid the formation of a shoulder.

Counter-sunk bolt or rivet.—A bolt or rivet in which the head is conical in form and is let in to the

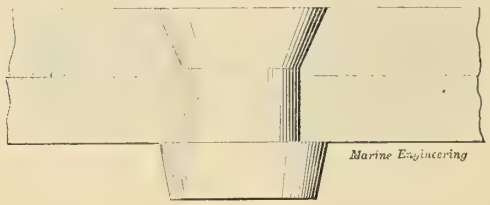


Fig. 37.

part to be held in such way that there is little or no projection beyond the surface. See Fig. 37.

Coupling.—In general, a means of connecting two moving members of a machine. In particular, the means used to connect the successive lengths of shafting. This consists usually of a pair of flanges connected by bolts, as shown in Fig. 38. Another style of coupling is used for connecting shafts by a sleeve without the use of any enlargement at the end of either part. Such couplings are sometimes used to couple the length of shaft, which passes outboard through the ship's skin, to the length next forward. Couplings of this type are also carried for

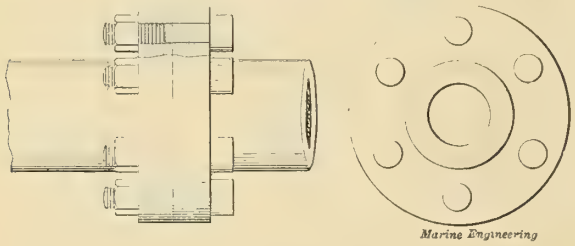


Fig. 38.

emergency purposes in case of a broken shaft. Between the crank-shaft and line-shaft a special style of coupling is sometimes provided of such form as to serve the purpose of a universal joint. This provides a flexible coupling between the two lengths of shafting and thus allows a slight difference in alignment between them.

Coupling Flange.—The flange of a shaft coupling.

Cross-Head.—The part of a steam engine which serves to join the connecting rod with the piston. The typical modern marine cross-head as shown in Fig. 39 comprises an approximately cubical body, through which passes the piston-rod secured by a nut

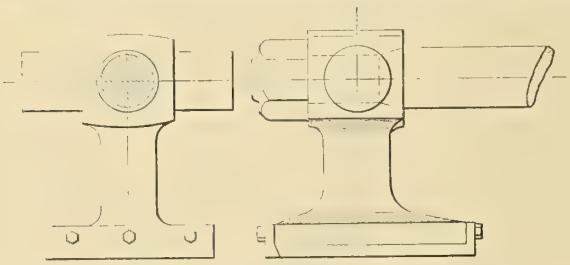


Fig. 39.

on the lower side. On either side fore and aft are attached the cross-head pins which connect with the forked extremity of the connecting-rod. On one or both sides laterally are attached the slide surfaces which bear on the guides, supported in turn by the columns. In the so-called *slipper* cross-head as shown in the cut there is but one slide or *slipper*. In such case with go-ahead motion the outer surface of the slipper bears on the surface of the guide, which thus receives and supports the transverse force due to the obliquity of the connecting-rod. For backing motion the corresponding force is taken on the inner faces of the slipper, which bear on cheek pieces attached to the column. Referring to *connecting-rod*, it will be seen that the form of cross-head in Fig. 39 corresponds to that form of connecting-rod which carries the bearings for the cross-head pins. For the other type of connecting-rod the cross-head must provide a bearing for the pin which in turn is rigidly attached to the rod as described under that heading. In such case, Fig. 40, the lower end of the piston-rod is forged out so as to form the support for this bearing so that a part of the cross-head and the piston-rod are of one and the same forging. The arrangement of guide surfaces may be the same in either type of cross-head.

Crow-foot.—A form of boiler brace in which the end is spread out into two or more points of attachment to the shell. Forms of the brace in which the points of attachment are more than two are now nearly obsolete.

Crown or Crown-sheet (of combustion chamber or furnace).—The highest plate in a combustion chamber or furnace, and hence the place most likely to be uncovered in case of low water.

Crown-bar.—A form of brace used for supporting the flat top of a combustion chamber. This is shown

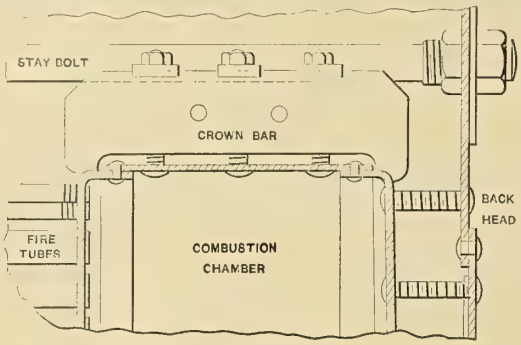


Fig. 41.

in position in Fig. 41, which represents the top of the combustion chamber of a Scotch boiler and neighboring portions of the boiler. See *Boiler.*

Cushion.—*Compression.*

Cut-off (to).—As a verb the word denotes the act of closing a slide valve used to admit steam to a cylinder. This operation is effected before the end of the stroke in order to cause the steam to work expansively for the remainder of the stroke. As a noun the word refers to the act of closing a steam valve, or to

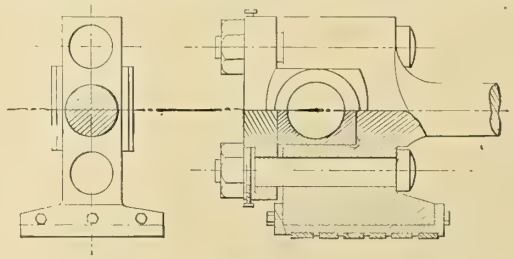


Fig. 40.

the point in the stroke or on the indicator card at which it is effected.

Cylinder.—In general any body of cylindrical form. More particularly a part of an engine or pump containing a movable piston and a gas, vapor or liquid under pressure. The cylinder of a steam engine re-

ceives the steam from the steam-chest alternately in each end and enables it to act on the piston, thereby producing the movement of the latter and through it the motion of the connecting-rod, crank and shaft. The cylinders of marine engines, see Fig. 42, are of cast-iron and consist essentially of a cylindrical body or barrel with which is usually cast the *lower* or *bottom head*. With the cylinder are usually cast also the valve casings or chests and all ports and passages, as well as the necessary feet for attachment to the columns, lugs for attaching braces, etc. The *top head* or *cover* is cast separately and is secured to an appropriate flange on the barrel by means of stud bolts. In many cases working liners are fitted within the barrel

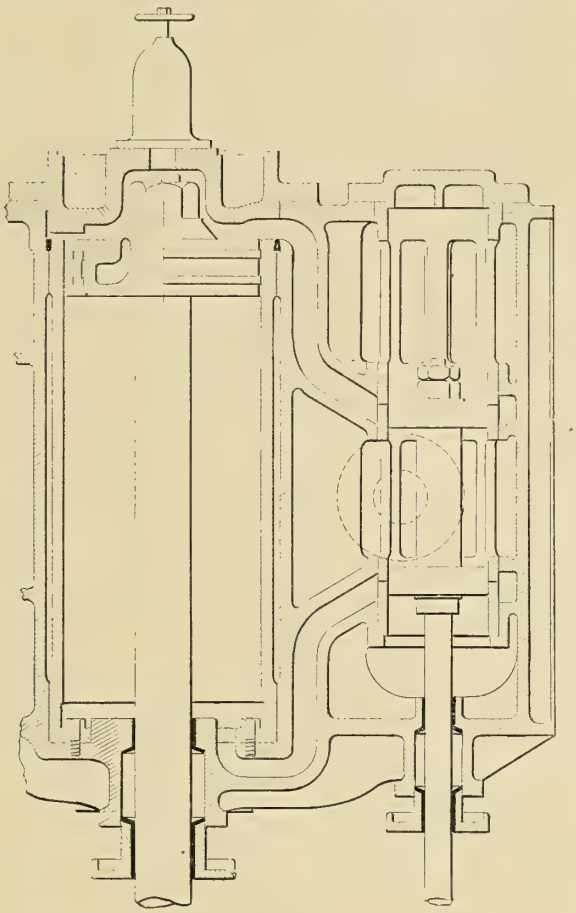


FIG. 42.

or cylinder proper. These are of extra hard and fine grained iron, and are fitted especially to provide a wearing surface and to admit of replacement in case of excessive wear. If the cylinders are to have steam jackets, liners must be fitted, the space between the barrel and liner providing the jacket space required. Cylinders as well as jackets are usually provided with *drain cocks* or *valves* with suitable piping so that water collecting within them may be drained away. In addition, *automatic relief cocks* or *valves* should be fitted, capable of opening under appropriate pressure, and thus furnishing relief in case a large quantity of water may find its way into the cylinder. The cylinders are supported on the columns and for mutual support are quite commonly tied together by braces, or flanged and bolted to each other. Fig. 42 shows the high pressure cylinder of a triple-expansion marine engine, with the valve chest and piston valve.

T. H. Chappell, of New London, has been credited with the purchase of the Old Field Shipyard, at West Mystic, Conn.

QUERIES AND ANSWERS.

If our western correspondent who signs himself "Engineer" will send his correct name and address, his query regarding indicator cards will receive attention, otherwise not. EDITOR M. E.

Q.—Will you please tell me in your next issue what is meant by the clearance of an engine?

SUBSCRIBER.

A.—You will find an explanation in the *Engineers' Dictionary* in Marine Engineering for September, page 39.

Q. What is the proper ratio between the area of steam and exhaust pipes? R. S.

A.—Where there are no structural limitations as to the size of pipes and passages, a very common rule is to make the exhaust passage 50 per cent larger, or one and one-half times the size of the steam passage. Due to limitations, however, it is often necessary to accept a smaller increase for the exhaust, as, for example, 30 per cent or 40 per cent over the size of the steam pipe and passage. The reason for an increase in size is that the exhaust may be as free and unobstructed as possible, and that the back pressure in the cylinder may be reduced to its lowest limits.

Q.—If the water cylinder of a pump is 6 in. in diameter, what is a suitable size for the steam end?

TOLEDO.

A.—Assuming that the pump were intended for boiler feed, or for fire and general service, the common diameter for the steam end would be about 10 in. The steam end is thus made larger than the water end in order that the total pressure on the steam side may be much greater than the resistance on the water side, and thus enable the pump to overcome the resistance of valves, pipes and bends, and to force the water back into the same boiler from which the steam is drawn, or against the same or even a greater pressure per square inch than that which acts on the steam side.

If, on the other hand, the pump were for light service, such as forcing water through a surface condenser or lifting water from the bilge and discharging it overboard, so great a total force on the steam side is not required, and the diameter of the steam cylinder would be about the same as that of the water cylinder, or in some cases even slightly less.

Q.—With the following data please work out the distance apart from center to center of stay bolts. $S = \frac{2H2C}{P}$. P = pressure per sq. in. = 150. S = distance between stays. C = constant, say 54,000, H = thickness of plate = 7-16"; let factor of safety 6 when C = 9,000? TEXAS.

A.—The rule you refer to in your letter does not agree with the one given in the United States rules. The latter will be found on p. 20 of the "General Rules and Regulations Prescribed by the Board of Supervising Inspectors of Steam Vessels," issue of 1896, and is as follows:

"When plates 7-16 inch thick and under are used in the construction of marine boilers, using 112 as a constant, multiply this by the square of the thickness of the plate in sixteenths of an inch. Divide this product by the square of the pitch or distance from center to center of stay bolt."

"Plates above 7-16 inch thick, the pressure will be determined by the same rule, excepting the constant will be 120."

Using the rule with your data we should have:

$$150 = \frac{112 \times 49}{\text{Square of pitch.}}$$

From this we find:

$$\text{Square of pitch} = \frac{112 \times 49}{150} = 36.6$$

Hence pitch = 6 in. nearly.

Screw stay bolts are rarely fitted with so close a spacing as 6 in., and a 1-2 in. plate and 7 in. spacing, for which the allowed pressure is 156 lbs., may be recommended as a preferable arrangement.

Q.—What is the formulae to find the amount of power required to drive a vessel at a given speed?

J. G. McC.

A.—No formula for the powering of ships has ever been devised which will admit of use except as the user is guided by experience, either his own or that of others. On the other hand many formulae have been devised in order to make possible the use of such experience in the solution of this problem. One of the simplest and perhaps of the widest use is the so-called *Admiralty Displacement* formula or *Admiralty Coefficient* formula. This is as follows:

$$H = \frac{D^{2/3} \cdot v^3}{K}$$

In this formula,

H denotes the *I.H.P.* required.

D denotes the displacement in tons.

v denotes the speed in knots.

K denotes the coefficient whose value is to be determined in accordance with the special circumstances of the problem. The displacement D is, of course, proportional to the volume of the immersed body, and the expression $D^{2/3}$ or the square of the cube-root of the displacement represents a surface—the face of a cube, in fact, whose volume in cubic feet would equal the displacement in tons. The other definite factor is v, the speed, which is raised to the 3d power in the formula. To these two quantities the power is related by means of the coefficient K, which depends upon and must take care of all other conditions which may affect the question of power. Such are the *proportions* and *form* of the ship and the relation of the speed to them and to the length, the character of the *surface* of the ship as affecting the skin resistance, the mechanical efficiency of the engine, and the propulsive efficiency of the propeller.

Now the relation of these influences to the power required is only imperfectly known, and we cannot therefore substitute for K mathematical expressions involving them, and thus have an entirely definite formula throughout. We must instead determine a value for K by other means, and there are in general two methods followed in this selection of a suitable value.

The first and older one is to select a value simply by judgment, based on a knowledge of the special circumstances, and guided by experience in a general way. The second and more modern is to assume the extension of the so-called *law of comparison* to the entire resistance of the ship, and then, as authorized by this law, determine the coefficient for any given set of conditions by a comparison with experimental results for other ships of similar form and like conditions, and at speeds related to the desired speed of the given ship in a manner to be explained directly.

With the first method the value is simply selected by judgment and without other than mental comparison between the proposed conditions and others of a generally similar character with which the designer may be familiar. With relatively long fine ships designed for moderate speeds (say not much exceeding in knots 2-3 to 3-4 the square root of the length in feet) and with good machinery and efficient propellers the value of the coefficient may rise to 275 or even to 300 in extremely favorable cases. As the ship becomes more full in form or relatively broader, or as the speed is relatively higher (approaching a speed in knots equal to the square-root of the length in feet), the values are usually found from 260 or 270 downward to 220 or less. As the form becomes relatively still broader and fuller, or as the speed is relatively still higher (reaching values in knots of 1 1-2 to 2 times the square-root of the length in feet), the value of K decreases down to 100 or even less for small boats, not of particularly good form, and driven at extreme speeds. The range of values for good average practice is usually found between 220 and 270.

With the second mode of treatment use is made of the extended law of comparison which, for the present purposes, may be expressed in the following terms.

Similar ships at corresponding speeds have the same Admiralty coefficient.

By *similar* ships is meant ships with similar proportions and characteristics of form, and with generally similar or equally efficient engines and propellers. By *corresponding* speeds is meant speeds at which the two ships will be surrounded with similar wave configurations. This is very closely attained when the ratio of the two speeds equals the square-root of the ratio of the lengths.

When, therefore, a problem is to be solved by this method, search must be made for data relative to a similar ship at a corresponding speed. The value of the coefficient may then be derived by the use of the known data, and the same coefficient then used with the values of D and v for the proposed case will give the corresponding estimate of power as desired. If several estimates are made in this way from different ships, each may be considered as furnishing an approximate value, and the mean may be taken, or such other value as may seem suitable in view of special circumstances.

The latter of the two methods thus outlined is much the more scientific, as it provides a definite mode for the utilization of results derived from previous experience, but there is still need for the exercise of much care and judgment in deciding on how closely the ships must be similar in order to allow of a reasonably safe appreciation of the rule, and as to questions of difference in details of machinery, propellers, conditions of trial, etc.

As an example of the use of this method by comparison, suppose that we have a proposed ship of length 300 ft., displacement 3,000 tons, and speed of 17 knots. A search among the available trial results for generally similar ships furnishes four examples as follows:

(1) $L = 250$ Disp. $= 1900$
(2) $L = 350$ Disp. $= 4500$
(3) $L = 320$ Disp. $= 3600$
(4) $L = 220$ Disp. $= 1200$

For (1) the speed v corresponding to 17 knots will be given by the proportion:

$$v : 17 :: \sqrt{250} : \sqrt{300}$$

$$\text{or } v = 17 \sqrt{\frac{250}{300}} = 15.5$$

Turning now to the trial results for this ship we take the power at 15.5 knots, and from these known values of *power, displacement* and *speed*, find the corresponding value of K. This is done by reversing the horse power formula above so as to read:

$$K = \frac{D^{2/3} \cdot v^3}{H}$$

Suppose the value of K thus found to be 220. We then use this value in the power formula with the values of D and v for the *proposed* ship, and find 4,645 as the value of the I.H.P. according to this means of estimate. From ship (2) we derive similarly a coefficient of 230 and a power for the *proposed* ship of 4,443, while from (3) and (4) we similarly derive coefficients of 215 and 225, and powers for the *proposed* ship of 4,753 and 4,541. Taking the mean of these four values we have 4,595, and we may feel a reasonable confidence in such a value, or say 4,600, as the power necessary in the given case, provided the ships are approximately similar, and the conditions under which the trial results were taken were normal and regular in each case.

By the method of determination first described, instead of finding, as above, values of the coefficients 220, 230, etc., it is simply necessary to assume a value of K off hand, as 225, for example, bringing to bear on the choice such general judgment as experience may furnish.

For finding the values of $D^{2/3}$, engineering hand-books often provide special tables giving the two-thirds powers of numbers. If such a table is not at hand, it may be remembered that the quantity desired is the square of the cube-root or the cube-root of the square, and hence the ordinary handbook with tables of squares and square-roots, cubes and cube-roots will provide a means for finding the values desired.

"A Catechism of the Steam Plant," chiefly for the use of stationary engineers, by F. F. Hemenway, has just been issued from the press of "Locomotive Engineering," New York. It is a book suitable for the instruction of engineers who intend to prepare themselves for the better class of positions. The price of the catechism is 50 cents, a thoroughly good investment.

TECHNICAL PUBLICATIONS.

THE INDICATOR HANDBOOK. By C. N. Pickworth, Whitworth Scholar, Part 1, 1898. New York, D. Van Nostrand Co., 23 Murray street. With many illustrations. Size, 5 by 7 1-2. Pages, 130. Cloth, $1.50.

The book treats of the Indicator as an instrument only, leaving the subject of the indicator diagram and its analysis to a second part of the work now in active preparation. At first sight it would seem that the indicator has been pretty thoroughly discussed, but a careful perusal of this work will convince that there is still much to be said which is new and interesting. The first chapter gives detailed description and illustrations of the development of the instrument, showing all the trouble-saving devices of the modern varieties, as well as indicators for hydraulic, ammonia and gas engines. Then follows a very instructive description of errors which are caused by faulty handling of the instrument itself under certain conditions, and errors of attaching it. Although intended for general steam engine work, the subject of reducing gears may be well studied by marine engineers, as there are many devices shown which would be very handy in engine rooms where space is valuable.

JUSTUS PERTHES' DEUTSCHER MARINE-ATLAS (German Navy Atlas). Compiled by Paul Langhaus, with notes by Lieutenant Commander A. D. Bruno Weyer, Imperial German Navy. Justus Perthes, Gotha, Germany, 1898. Size, 8 by 12. Pages of text, 12; maps, 5. Paper covers, 1 mark.

This pamphlet contains a complete list of the ships of the German navy, including those now under course of construction, giving their displacement, speed, power, armament, etc., and their location up to July of this year. A number of carefully drawn colored maps show the positions of coaling stations, navy yards, coast positions open to attack and coast fortifications in Germany, as well as in all the German colonial possessions. A short description of the services performed by the various vessels since 1872 is of interest, also tabulated statements of expenses and appropriations of the navies of different countries and the proportions of the same to the foreign investments of these countries. It also includes a short description of the development of the German merchant marine and a comparison between total tonnage of German and foreign vessels sailing to German ports, also a list of vessels available for auxiliary cruisers. Altogether it is an exeremely valuable work of reference. In points of typographical excellence it is a thoroughly good job.

A HANDBOOK OF ENGINEERING LABORATORY PRACTICE. By Richard Addison Smart, M.E., Purdue University. John Wiley & Sons, New York. First Edition, 1898. Size, 5 by 7 1-2. Pages, 290. With Many Illustrations. Cloth, $2.50.

This is a carefully prepared practical work for a specific purpose, viz.: "To provide in a convenient form such directions for the conduct of various tests and experiments, comprising the course, as the student will need to enable him to take charge of and conduct the particular work assigned to him in an intelligent manner and with little delay." Or in other words granted the reader has a theoretical knowledge of what he is about to undertake in the way of tests for efficiency, etc., this book will direct him how to proceed to put his theory into pactice, and if he is apt it will save him the trouble of asking a lot of questions. Each set of instructions is complete, so that the student will not have to hunt through the whole book for information necessary in any one test, but will rather find it properly labeled and ticketed where it belongs. Opening with a few practical suggestions on routine, the author treats successively of Measurements; time, speed, areas, lineal, liquids, gases, pressure, temperature and power. Then follow in order Strength of Materials; Steam Boiler Testing; Steam Engine Indicator; Testing of Hydraulic Machinery, and miscellaneous tests. Usual convenient tables of reference are attached, saving time in computation. Very appropriately, the author has selected for his frontispiece an engraving of the locomotive testing plant at Purdue, for this university is widely known as the place of origin of many important locomotive tests. In the text, too, he has given space to this special branch of laboratory work. Throughout the book there are a number of explanatory diagrams and drawings, and also some engravings showing the general appearance of apparatus referred to. These latter are mostly shopworn, and disfigure an otherwise neat and clearly printed book.

TRADE PUBLICATIONS.

Several types of valves manufactured by the Roe Stephens Mfg. Co., Detroit, Mich., are illustrated and briefly described in an 8-page folder, which is ready for distribution. Users of valves will find it instructive.

"There Is Nothing So Rare as Resting on Air" is the title to a pocket size pamphlet issued by the Pneumatic Mattress & Cushion Co., Reading, Mass. The explanation of the title can best be understood by sending for a copy of the pamphlet.

"How the Greatest Peril to Navigation Was Overcome" is the title of a 32-page pamphlet issued by the Eophone Co., 11 Broadway, New York. It tells in much detail what the eophone is and its many advantages for detecting sounds at sea and preventing collision. Copies can be had upon application to the company.

Powell's steam brass goods are described in a pocket edition catalogue of about 100 pages. The catalogue is thoroughly illustrated, averaging several pictures to a page, and is carefully indexed. In addition to the full line of goods manufactured by this company there is in it an amount of valuable information, mathematical, engineering, etc. Copies can be had by writing for them and mentioning MARINE ENGINEERING, to Wm. Powell Co., Cincinnati, O.

"Search Light Projectors" is the title of an exceptionally well printed and illustrated catalogue of 24 pages issued by the Carlisle & Finch Co., 834 West Sixth street, Cincinnati, O. The illustrations are excellent, and the printing in red and black gives a neat effect. Altogether it is a very satisfactory catalogue, and one that every user of search lights will find quite valuable for purposes of reference and general information. Copies can be had upon application to the company.

Steam regulating devices and steam pumps manufactured by the Mason Regulator Co., 6 Oliver street, Boston, Mass., are thoroughly illustrated and described in much detail in a 40-page pocket-size price list and catalogues just issued. Many of these devices are particularly designed for marine work, making the catalogue quite a necessary feature among the reference publications of every use of such devices. Copies of the catalogue can be had upon application to the company.

The American School of Correspondence, 156 Tremont street, Boston, Mass., has issued a small folder of testimonials of students who have taken a course at this institution. The school is chartered by the State of Massachusetts for the special purpose of giving a technical and practical education, by means of correspondence, to young men who have not the time nor the means to attend any of the established schools. The list of instructors include some eminent mechanical experts. Copies of this catalogue and other information can be had upon application.

BUSINESS NOTES.

VERMIN EXTERMINATORS.—One of the worst pests on board vessels of all kinds is the roach, which is difficult to exterminate. A remedy made especially for destroying roaches and ants is offered by the Allison Chemical Co., 143 East 23d St., New York.

ELECTRIC LIGHT ENGINES.—Marine electric plants need an engine of peculiar capabilities, and in order to supply the demand, the Fore River Engine Co., Weymouth, Mass., carries in stock a number of sizes of engines made especially for direct connected electric work.

MATTRESSES AND CUSHIONS.—The Perfection matresses and cushions, manufactured by the Mechanical Fabric Co., Providence, R. I., are made with special reference to marine work. It is claimed for them that they are always dry, that there is no mustiness.

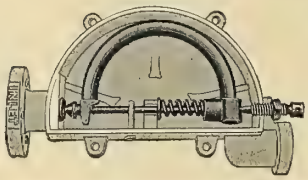
SAIL MAKING.—M. W. Fogg, 195 Front St., New York, reports a larger volume of business than he has ever experienced at this season of the year. His shop is full of work for sails, covers, cushions and other work in his line, both for merchant vessels and for yachts. His facilities are not taxed to such an extent however as to preclude filling orders promptly.

A COLD PROCESS OF GALVANIZING.—A new process for galvanizing is being put on the market by the U. S. Electro-Galvanizing Co., 346 Broadway, New York. Many advantages are claimed for this process, among them the following: Screws and nuts need no recutting, tools, locks and almost anything metallic can be plated, springs preserve their elasticity and temper, as no heat is used, designs retain their original form, as their coating is uniform, sheet metal or wire can be bent without injury to the galvanizing, the operation is thorough, so that salt water does not cause oxidation, much less metal is wasted.

23 Years

in constant use — and no failures. Thousands of dollars saved by the "Heintz" Steam Trap. Simple — Durable — Efficient. Works in any position — discharges water to any height. No floats, no levers or delicate parts. Economizes fuel and labor — saves space — perfectly automatic—requires no watching. Money refunded if trap proves unsatisfactory within a year. Send for one on thirty days' trial free.

Booklet "G" for the asking, will show you how to save money.



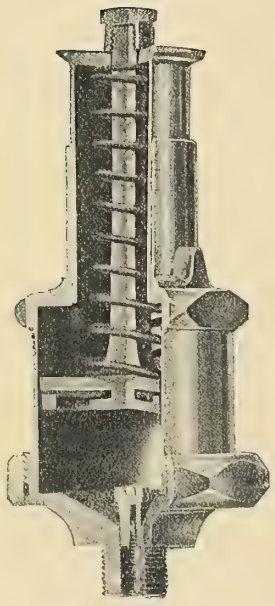
William S. Haines Company,

136 South Fourth Street, Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y.

"LACKAWANNA" GREASE CUPS.



For Use On Journals

(Big and Little).

Give Positive Lubrication Under All Conditions.

They are....

Not "Blind Cups."

Every "Lackawanna" An

...Index Cup...

THE LACKAWANNA LUBRICATING CO.,

No. 1218 Capouse Ave., Scranton, Pa.

AN OPPORTUNITY FOR MARINE ENGINEERS.

AMERICAN SCHOOL OF CORRESPONDENCE

(Chartered by the Commonwealth of Massachusetts)

Offers a Thorough Course in

MARINE ENGINEERING.

We make a SPECIALTY of teaching Steam, Electrical and Mechanical Engineering.

Our COURSES are thorough and practical.

Our ADVISORY BOARD consists of experts of world-wide fame.

Our INSTRUCTORS are graduates of the best technical schools.

Our TERMS are low and within reach of every wage-earner.

Hundreds of ambitious ENGINEERS, ELECTRICIANS and MECHANICS have secured better positions and larger salaries through the up-to-date technical education received from our school. We have helped others and we can help YOU.

Special Offer to Readers of "Marine Engineering."

33⅓% REDUCTION. For another 30 days we will FOR 30 DAYS.

continue to offer 33⅓% REDUCTION from our regular tuition fee to all readers of MARINE ENGINEERING. Write for our new handbook "N" containing schedules of courses, names of instructors, pages from instruction papers, etc.

AMERICAN SCHOOL OF CORRESPONDENCE,

BOSTON, MASS.

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

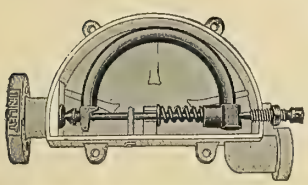
It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

An Extra Engineer

not needed to look after the "Heintz" Steam Trap. It's automatic, sensitive, lasts for years. Operates by expansion of sealed tube, which closes the valve as live steam enters the trap — 212°: valve open at 211°. Smallest size discharges a gallon of water a minute.

Guaranteed to give best results and save coal and steam. Our Booklet "G" interesting to users. Ask for it.



William S. Haines Company,

136 South Fourth Street, Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 12

ICE YACHTS.—A department for building ice yachts has been established by the Spalding St. Lawrence Boat Co., Ogdensburg, N. Y. This department is under the charge of Mr. George E. Buckhout, one of the leading designers and builders of ice yachts.

CONCERNING MECHANICAL DRAFT.—The elaborate treatise on mechanical draft recently issued by the B. F. Sturtevant Co., of Boston, Mass., is unique as a trade publication, in that it presents no personal claims for the merit of the system or the apparatus necessary for its operation, but relies solely on the statements of unbiased witnesses to emphasize its features. For this reason, the following quotation from this important work is of especial interest and value. It consists of a summary of the especial advantages of mechanical draft as presented by the well-known engineer, Mr. Alfred Blechyden, in a paper before the British Institution of Mechanical Engineers. He says: "First, it seems fairly well established that, if the boilers are well constructed and are provided with ample room to insure circulation, their steaming power may without injury, be increased to about 30 to 40 per cent over that obtained on natural draft for continuous working, and may be about doubled for short runs. Secondly, such augmentation is accompanied, in normal cases, by an increased consumption per indicated horse power. But, thirdly, the same or even greater power being indicated it may, with moderate assistance of forced draft, be developed with a smaller expenditure of fuel, the grates, etc., being properly proportioned. Fourthly, forced draft enables an inferior fuel to be used; and, fifthly, under certain conditions of weather, when with normal proportions of boiler it would be impossible to maintain steam with natural draft, the normal power may with forced draft be ensured. In particular cases any or all of these advantages may be a source of economy; and the first of them may render possible that which would otherwise be impracticable."

"To Whom It May Concern."

There is nothing more important about an engine than the bearings. If the manufacturers of engines of any kind will consult us in regard to same, we will give them an Anti-Friction metal for wear and durability that cannot be excelled.

For marine engines our

WHITE BRONZE

is the best; contains no lead, and will not mix with a metal that does. Its specific gravity is lighter than any "Genuine." We have on hand all grades of Babbitt and Anti-Friction metals, copper-hardened down to 8c. per lb. All of our metals run as freely as the wearing properties put into same will permit.

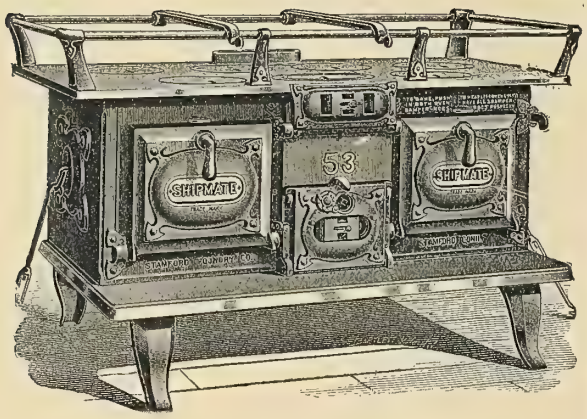
Write us, those of you who are interested in the use of good metals.

PITTSBURGH WHITE METAL CO.,

PITTSBURGH, PA.

BETHLEHEM FORGINGS.—The steam yacht Oriénta, which is owned by Mr. Edward R. Ladew, of New York, broke her main shaft on the morning of the Naval Review in New York Harbor. An order for a new shaft has been placed with the Bethlehem Iron Co., South Bethlehem, Pa.

MARINE FIRE ALARM TELEGRAPH.—A committee of fire underwriters recently made an exhaustive test of the multiphase cable manufactured by the Montauk Fire Alarm Co., 100 Broadway, New York. In closing the report the committee said: "It is simple in action, and reliable as a fire alarm adjunct. The Montauk Multiphase Cable is practically a substitute for a thermostat, and this cable being run in out-of-the-way places, or in dangerous localities where fire is liable to occur, really makes a continuous thermostat, ready at all times for action in case of fire or dangerous heat at any point where the cable runs." This cable is particularly adapted to wiring vessels.



SHIPMATE

Not the only caboose range on the market? No, but is there another so universally liked? There is a reason for such popularity.

THE STAMFORD FOUNDRY COMPANY,
STAMFORD, CONN.

Established 1830.

Paint in the U. S. Navy

The U. S. Navy Department is not sentimental, and is not easily influenced by advertisements. Materials are tested by official experts and accepted or rejected on their merits. Paints are no exception to this rule.

The results of such tests led, long since, to the adoption by the Department, of Zinc White ground in refined linseed oil as the base for all paints used on our warships. Other pigments and other colors are used for various reasons, but zinc white is the "bed rock" pigment in every case, because zinc white makes paint durable.

Ten tons of zinc white, of American manufacture, is the ordinary cruising allotment for each ship, and it goes into every paint used about the ship, from red lead to yellow ochre. The Department had originally some prejudices in favor of imported zinc and poppy oil, but they went down before the cold logic of practical demonstration, and to-day American paints are used on American ships.

The fame of the beautiful "White Squadron" was founded on the superior qualities of Zinc White, which is the only white pigment that will hold its color and resist the action of sea air and sea water and the vicissitudes of changing climates.

New Jersey Zinc Company.

REDUCING VALVES

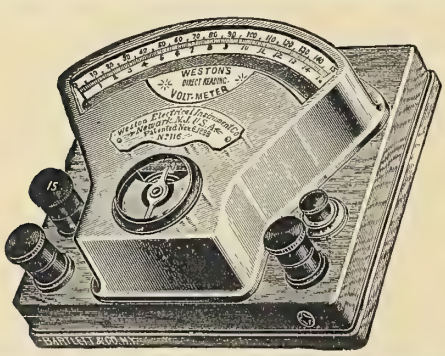
to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.



Weston Standard Portable Direct Reading Voltmeter.

WESTON STANDARD PORTABLE

DIRECT READING

VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Intruments are recognized as **THE STANDARD** the world over. Our **VOLTMETERS** and **AMMETERS** are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.,
114-120 William St., NEWARK, N. J., U. S. A.

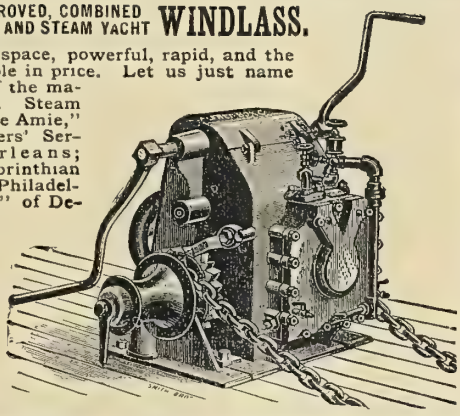
GOVERNMENT ORDERS.—J. L. Robertson & Son, 218 Fulton street, New York, inform us that the United States Government specified Eureka Packing for use in all of their war vessels and used a number of Robertson Thompson Indicators.

BULKHEAD LINING.—The advantages of asbestos fire board for bulkhead lining has been demonstrated in many ways. It is particularly adapted to the work, as it does not shrink, is fire proof, water proof and vermin proof. A recent test of the fire proof qualities of the board ignited pine wood protected by varnish in 1-3 second; protected by sheet iron in 15 seconds, and protected by a thin piece of asbestos fire board in 7 minutes. The temperature of the heat in each instance was 4,000 deg. F. This board is made by the New York Asbestos Co., 287 Douglass St., Brooklyn.

BOX'S IMPROVED, COMBINED HAND AND STEAM YACHT **WINDLASS.**

Minimum space, powerful, rapid, and the most reasonable in price. Let us just name one or two of the machines in use. Steam Yachts—"Chere Amie," U. S. Engineers' Service, New Orleans; "Manatee," Corinthian Yacht Club, Philadelphia; "Truant," of Detroit, Mich.

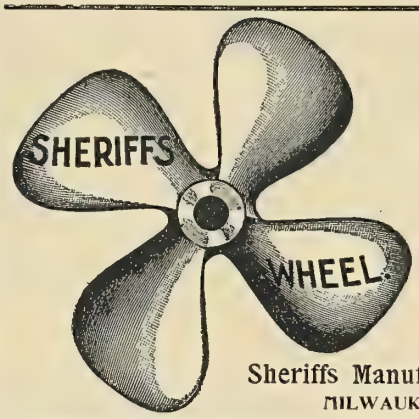
Particulars Cheerfully Furnished.



ALFRED BOX & CO.,

Front, Poplar & Canal Sts.,

PHILADELPHIA, PA



Sheriffs Manufacturing Co.,
MILWAUKEE, WIS.

PROFESSIONAL CARDS.

H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.

Manufacturer of **Screw Propellers** for Usual and for Special Work.

The Allen Dense Air Ice Machine for Steam Vessels.

41 MAIDEN LANE, NEW YORK.

GUSTAV HILLMAN,

NAVAL ARCHITECT.

Designer of all classes of **Vessels. Steam Yachts a Specialty.**

470 GREENE AVE., NEAR NOSTRAND, BROOKLYN, N. Y.

Paul S. Reeves & Son,

PHILADELPHIA, PA.,

Manufacturers of

Propeller Wheels

in all the BRONZES.

Marine Castings a Specialty.

Phosphor-Bronze, Brass, Babbitt Metals.

Castings from ¼ to 10,000 lbs. Weight.

ELECTRICITY FOR MARINE ENGINEERS

Every intelligent engineer appreciates the fact that a working knowledge of electrical engineering has now become one of the conditions upon which many of the best positions depend.

Our Junior Course in Electrical Engineering meets this want. For our handsome illustrated **Free** book entitled **"Can I Become An Electrical Engineer?"** address

DEPT. S, THE ELECTRICAL ENGINEER INSTITUTE OF CORRESPONDENCE INSTRUCTION

HERMAN A. STRAUSS, E. E., General Manager — **120 LIBERTY ST., NEW YORK, U. S. A.**

ENDORSED BY EVERY PROMINENT ELECTRICAL ENGINEER

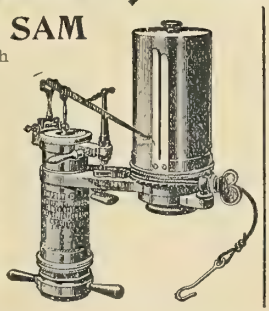
WHY DID WE, IN OUR LATE UNPLEASANTNESS WITH SPAIN,

deliver to **U. S. NAVY** more **"EUREKA" Packing** than all the other **Soft Packings Combined?** They recognize it as the best, and not one of the **War** Vessels went to sea without a full stock in their storeroom. Can you afford to pass it by without trying?

For 2 labels, showing weight, cut from front of **EUREKA** boxes we send a beautiful set of fancy playing cards.

Be sure this label in RED is on the box and every few feet of packing. All others are Imitations.

UNCLE SAM thought enough of our **ROBERTSON THOMPSON INDICATOR** to use a number of them on his war vessels. If you are interested send for circular and discount. **Price $60.**



For HIGH STEAM can you do any better than this?

Gentlemen:

The **FULTON FLEXIBLE METALLIC PACKING** you furnished us 3 years ago is still in use and has been so satisfactory we have just made requisition for more and will expect the same good quality. Yours truly,

E. DUBOIS,
C. Eng. Floating Equipment, Erie R.R

Price $1.25 per lb.

Jas. L. Robertson & Son, 218 FULTON ST. Boston Branch, 12 PEARL ST.

USE OF THE NAME PENBERTHY.—Judge Adams, of the Federal Court, has handed down a decision in favor of the Penberthy Injector Co., Detroit, Mich., against the organizers of the Lee-Penberthy Co., enjoining the use of the name Penberthy by that company and charging costs to the defendant.

MR. CLARK MERCHANT.—Mr. Clark Merchant, of Philadelphia, and Lieutenants Etting and Thackera in 1894 were the means of first starting the Naval Reserves of the State of Pennsylvania. Mr. Merchant was born at Oglethorpe Barracks, Savannah, Ga., in 1836. His grandfather, George Merchant, fought in the War of 1812, and his father, Charles Spencer Merchant, was one of the first cadets admitted to West Point. Clarke Merchant was entered in the United States Naval Academy as a cadet, and graduated as a midshipman in 1857. He was executive officer of the steamer "Toey-wau" and present when the English squadron was defeated by the Chinese forts on the Peiho river, his vessel towing the boats containing the English sailors and marines into action. Commodore Tatnall on this occasion made the memorable declaration that "blood is thicker than water." He served through the Civil War, and at the close of the war was ordered to the Naval Academy at Newport as executive officer of the frigate "Constitution." He resigned from the navy in 1865. His present business started by his becoming agent for the New Bedford Copper Co., handling principally sheathing metal. To this he soon added sheet copper, tin and other metals. More space became necessary, and Mr. Merchant moved to 525 Arch street and subsequently to 517 Arch street, where he now ocupies a store especially erected for the business. In this are stored the brass, tin, iron and other metals which make up the stock of the firm. He deals very extensively in brass and copper tubing, coppersmith's supplies, anti-friction metal, and almost all materials for shipwork. There are branch offices in New York, Chicago and London.

Westinghouse Machine Co.

....MANUFACTURERS....

Westinghouse, Church, Kerr & Co., Engineers

We Employ the Best Materials and the Highest Skill in the Manufacture of Our Ice Refrigerating Plants

Builders of the Engine Holding the World's Record for Economic Duty

WORKS AT PITTSBURG AND CHICAGO

OFFICES:

NEW YORK, 26 Cortlandt Street BOSTON, 53 State Street CHICAGO, 171 La Salle Street
PITTSBURG, Westinghouse Building DETROIT, Union Trust Building
PHILADELPHIA, M. R. MUCKLE, Jr., & CO., Drexel Building

PNEUMATIC TOOL PATENTS.—Judge Alfred C. Coxe, of the United States Court, has just rendered a decision in the case of the American Pneumatic Tool Co. vs. Volkening & Co., in which he sustains the validity of the Bagnasco patent, No. 474,154, for a valveless tool, owned by the American Pneumatic Tool Co., 844 Washington street, New York, and he finds that the defendants are infringers of this patent in the use of the infringing tool commonly known as the Keller tool.

A FREE SMOKE.—Every engineer who sends his address to the Litofuge Mfg. Co., 1710 Market St., Philadelphia, Pa., will receive a fine briarwood English bulldog pipe. These pipes are given for the special purpose of pushing the sale of Litofuge for keeping boilers clean. It is claimed to free the dirtiest boiler from scale in a short time, and to prevent the formation of scale in new or clean boilers. Pamphlets and other literature regarding Litofuge are sent to all inquirers.

APPARATUS FOR REVENUE CUTTER.—Revenue cutter No. 6, described in the October issue of Marine Engineering, and which is to be stationed in New York Harbor when completed, is fitted with Craig Heating and Circulating Apparatus, furnished by William Craig, 121 Liberty St., New York.

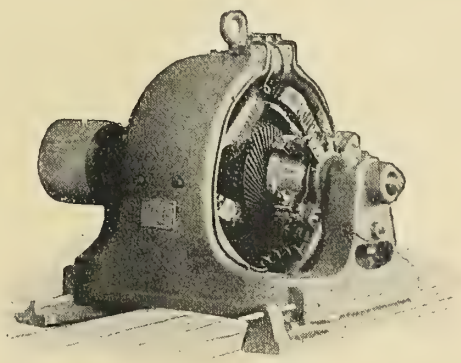
HOWDEN HOT DRAFT.—In a recent letter to the Dry Dock Engine Works, Detroit, Mich., Mr. Howden, the inventor of the hot draft system, reported having more orders on hand than at any time in the history of his business, the total installations throughout the world to date being 814 steamers with 2,277,300 I. H. P. Recent orders have been from steamers of unusually large power and among the customers are the following lines: Cunard line, Pacific Co., Orient Co., P. & O. Co., Atlantic Transport Line, Anglo-American Oil Co., Allan Line, Austrian Lloyds, Hamburg-American line, North German Lloyds, Russian Volunteer Fleet, French Line, Rotterdam Lloyd, Nederland Co., etc., etc.

Westinghouse Electric AND Mfg. Co.

The Most Perfect Motor

FOR

Economical Power Service



Aboard Ship

Westinghouse Direct Current Multipolar Motor

Builders of the "Engine-Type" Generator

WORKS AT PITTSBURG, PA.

Offices:

New York, Atlanta, Austin, Boston, Buffalo, Chicago, Cincinnati, Philadelphia, St. Louis, San Francisco, Syracuse, Tacoma, Denver, Mountain Electric Co. Canada, Ahearn & Soper, Ottawa. Mexico, G. & O. Braniff & Co., City of Mexico. Westinghouse Electric Co., Ltd., 32 Victoria St., London.

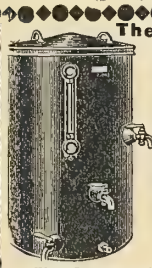
METALLIC PACKING.—Engineer Joseph F. Hayes, of the Zenith Transit Co., Duluth, Minn., wrote under recent date to the U. S. Metallic Packing Co., Philadelphia, Pa., as follows: "I have your packing on the Zenith City and Queen City, carry 225 lbs. of steam; on the Crescent, Empire, and Superior City carry 250 lbs. of steam. The Superior City has the record for ore and grain for a steamer up to date. Will say that the packing is working first rate on all the boats this season, and don't know what we would do without it with that pressure."

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

BUILDER AND ARCHITECT SEEKS POSITION.

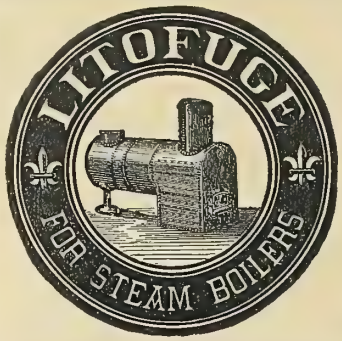
I wish to engage with a firm of Yacht or Launch Builders as Superintendent, Naval Architect, or in a position where ability and experience will count. Have had long and successful experience with well-known firms as Foreman, Superintendent and Naval Architect; have thorough knowledge of details, costs and construction. Can turn out work at reasonable cost and without waste. Am experienced with Steam and Gasoline Engines, have designed a number of successful Yachts and Launches and can introduce a large amount of paying business to a good firm. Address ARCHITECT,
MARINE ENGINEERING.



The **CROSS OIL FILTER**

actually reduces oil bills 50% or more. Sent on approval. Used in 17 countries. Adapted to steam vessels of every description. Send for circulars, testimonials, etc.

THE BURT MANUFACTURING CO.
AKRON, OHIO, U. S. A.
The Largest Manufacturers of Oil Filters in the World.



Free to Engineers.

Upon receipt of name and address and where employed, a fine English bulldog

BRIAR WOOD PIPE.

There's nothing like LITOFUGE for Marine Boilers.

It won't cost you a cent to try **LITOFUGE** unless it does just what we say it will do. We claim—

That it will clean the dirtiest boiler in 60 to 90 days, without injuring the metals;

That it is the *only* Compound that will *positively* prevent the formation of scale in a new or clean boiler;

That it will prevent corrosion, and stop it where it has already started;

That it does not eat the scale; simply loosens it from the metals.

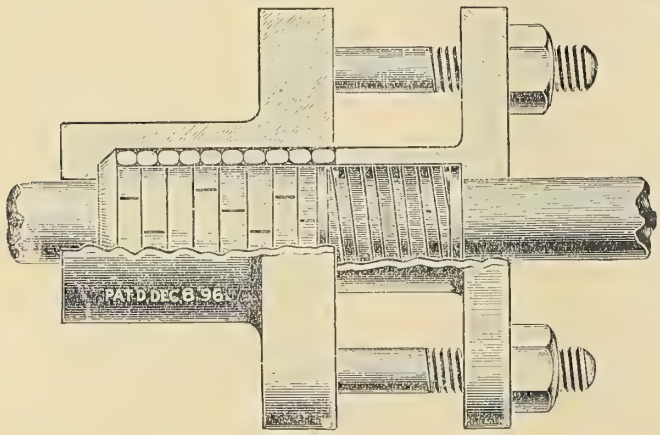
LITOFUGE acts mechanically (not chemically), contains no soda, soda ash, nor acid. Give us nominal horse power of your boilers and character of water used, and we will send you, freight prepaid, a trial order, to be paid for ***only*** if satisfactory. Pamphlet for the asking.

LITOFUGE MFG. CO.,
1710-1712 Market Street, PHILADELPHIA, PA.

There are a Number

of mediocre metallic packings on the market—some of them work fairly well for a short time—some of them work poorly from the start—all of them give more or less trouble—they cannot be adjusted while under load—they are dependent upon the steam or other pressure for their grip—they—but what's the use of talking? Like everyone else **YOU** are looking for a metallic packing combining the most good points with the fewest weak points; **WE** have found it and want **YOU** to know that—

RIGBY PATENT METALLIC ROD PACKING IS WITHOUT A PEER.



IT WILL HOLD—
Steam, Gas, Air, Water, Ammonia.

IT WILL WORK
at either light or heavy pressure with minimum friction.

IT WILL NOT
Grip nor Cut. Wear Out.

WRITE TO-DAY for Prices and Descriptive Circular.
Sole Manufacturers:

The Henry S. Mould Company,

Carnegie Building. PITTSBURG, PA.

LIBRARY
U. DEC 12 1898 S.
PATENT OFFICE.

MARINE ENGINEERING.

Vol. 2. NEW YORK, DECEMBER, 1898. No. 12.

DESCRIPTION OF THE STEAM YACHT ELLIDE AND HER SPEED TRIALS.

BY W. F. DURAND.

The steam yacht Ellide, designed by C. D. Mosher for E. Burgess Warren, of Philadelphia, has shown on trial such an unprecedented speed that a description of the boat and machinery and of her trials should be of great interest to all who are concerned with the advance of marine construction, and especially with the development of the highest attainable speeds on the minimum of size and weight. Through the kindness of Mr. Mosher, the author has been given access to this data in order that the results may be placed before those for whom they would naturally have this high interest.

Description of Boat.

The Ellide is 80 ft. long, 8 ft. 4 in. maximum beam, and, aside from the propeller, has a draft of about 2 ft. The normal displacement is about 13 tons. The boat is of composite construction, and is sub-divided by five steel bulkheads into six water tight compartments. The planking is of double skin mahogany, and all the fastenings are Tobin bronze bolts.

STEAM YACHT ELLIDE, DOING 27.3 MILES PER HOUR ON THE MEASURED MILE.

The accommodations shown in the plans on page 2 consist of a large cock-pit forward, fitted with steering wheel, compass and binnacle, speaking tubes and annunciators. Seats are also fitted on either side with drawers and lockers underneath.

Next abaft on the port side is a large ice chest and china closet, while on the starboard

Copyright, 1898, by The Marine Publishing Co., New York.—All Rights Reserved.

side is a toilet room with the usual fittings. Next abaft is the machinery space, aft of which is a dining room 18 ft. long provided with seats and drawers underneath, an extension table at the forward end, a pantry, suitable buffets, lockers, etc.

The forward and after decks are fitted with a bronze railing, while all the usual deck fittings, including the stack, are of polished brass. A permanent wooden awning is supported on brass stanchions, and glass windows are fitted so as to enclose at will the forward and after compartments. A light 13 ft. boat is carried on davits.

Machinery.

There is one Mosher patent quadruple-expansion engine, having cylinders 9 in., 13 in., 18 in. and 24 in. dia., by 10-in. stroke. All the cylinders are fitted with piston valves and have relief valves on both their upper and lower heads. The steam chests are fitted with automatic by-pass valves. The cylinders are not steam jacketed, but are well lagged with magnesia and encased in a polished brass casing with spun heads.

The valves are worked by an independent valve crank shaft parallel to the main shaft, and so geared to it by double helical gears as to make an equal number of revolutions with the main shaft. Reversing is accomplished in the usual way by a spiral sleeve actuated by a reverse lever at the forward end of the engine.

All the material used in the construction of the engine is of the highest class. The main parts of the engine are of steel forgings, oil tempered and bored out hollow, and all the usual fittings are supplied in accordance with advanced engineering practice. The engine as erected in the shop is shown in the engraving on page 3.

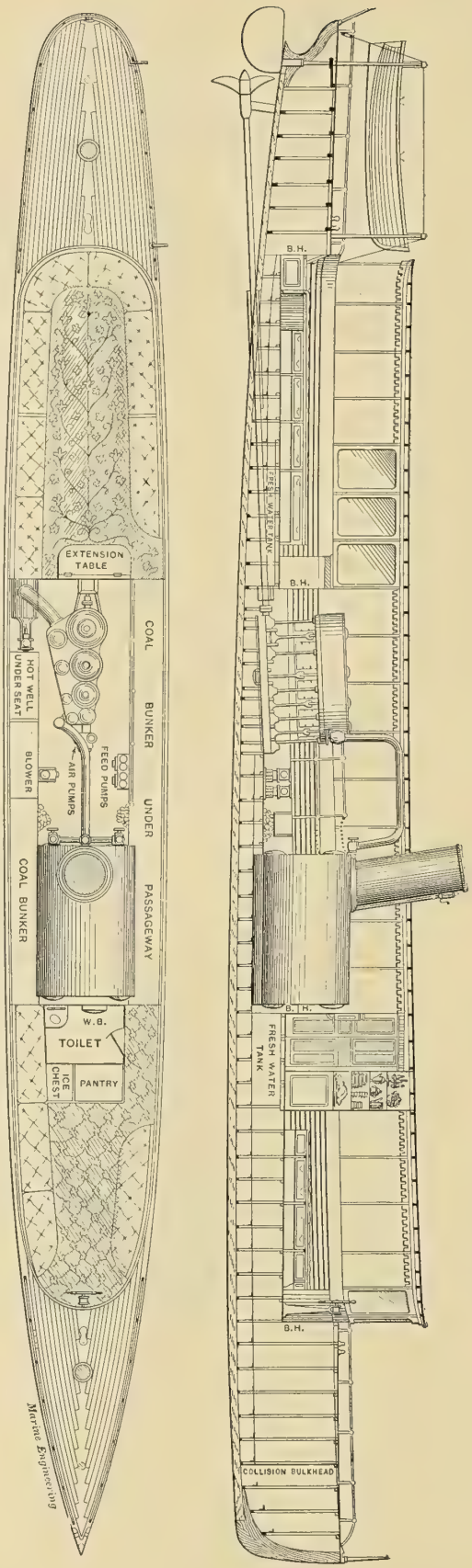
The propeller is 40 in. in dia. and of about 60 in. mean pitch.

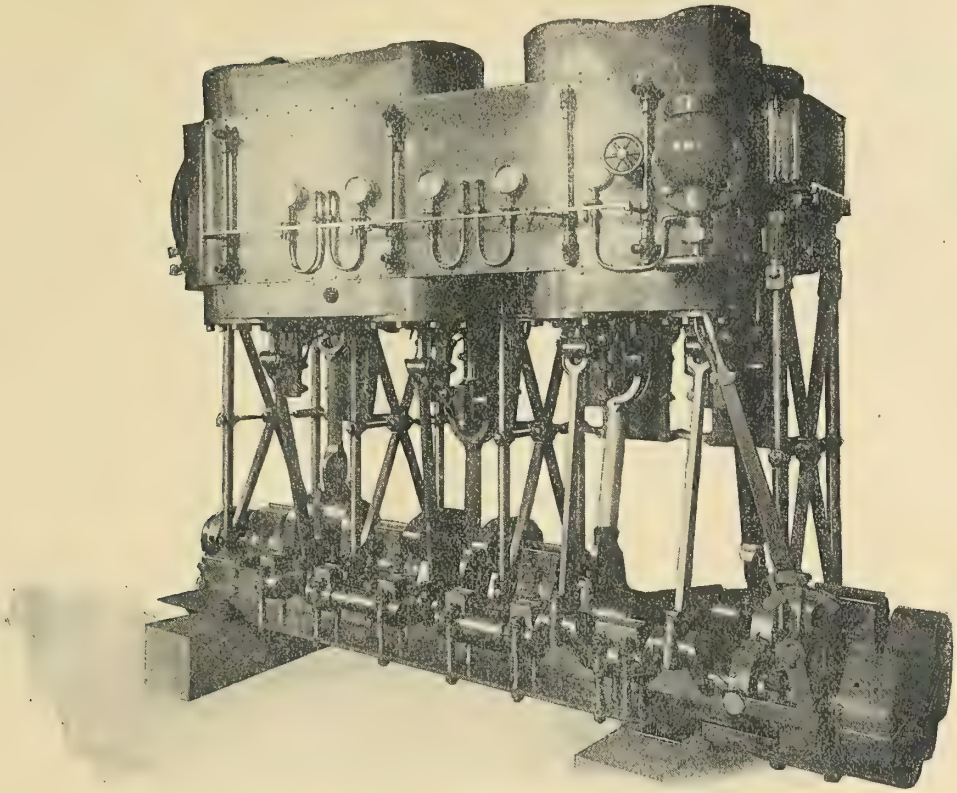
In addition to the main propelling engine there is an inboard surface condenser, and six specially designed auxiliaries, including feed-pumps, air-pumps, circulating-pump, bilge-pump and blower. The latter supplies air to the furnaces on the closed ash-pit system.

The boiler (illustrated on page 3) is of the Mosher Water Tube type, encased in polished brass. It consists of two steam drums placed over two water drums and connected together by a number of solid drawn steel tubes, so arranged that the gases pass twice the length of the boiler at right angles to the tubes before entering the stack, thus absorbing a high proportion of the heat liberated, and giving to the boiler a high efficiency. Each side of the boiler is practically independent, although the furnace is common to both.

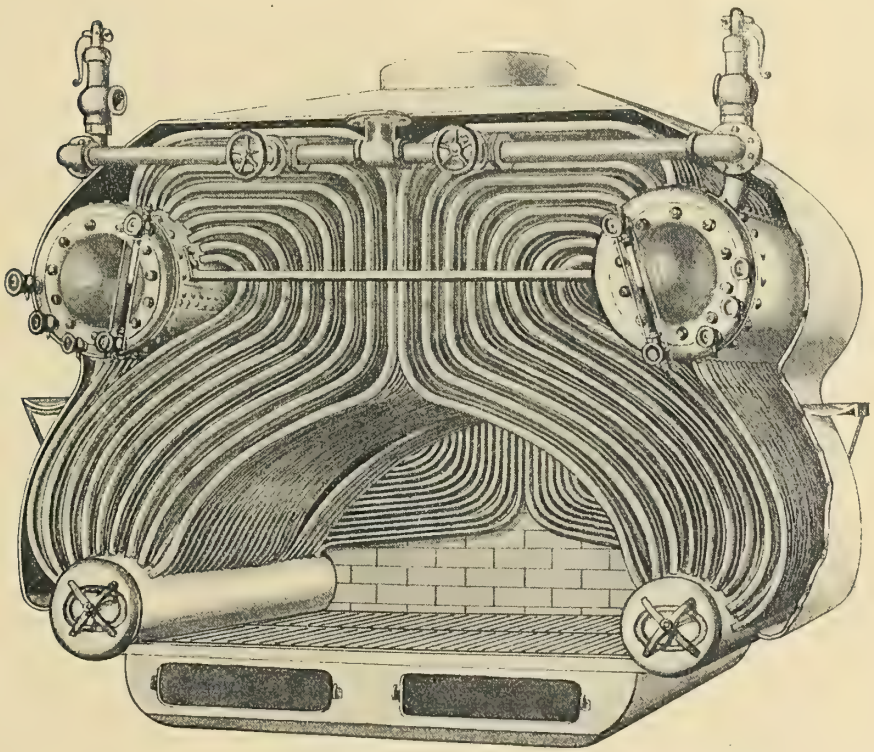
The boiler has 1,203 square ft. of heating surface and 30 square ft. of grate surface, and is similar to those now in use in nine of the torpedo boats of the U. S. Navy.

ACCOMMODATION PLANS OF THE SINGLE-SCREW STEAM YACHT ELLIDE, DESIGNED BY CHARLES D. MOSHER FOR E. B. WARREN, PHILA.





QUADRUPLE-EXPANSION ENGINE OF STEAM YACHT ELLIDE.



MOSHER WATER-TUBE BOILER OF STEAM YACHT ELLIDE.

Speed Trials on the Hudson.

The trials were carried out over the statute mile course of 5,280 ft., recently laid off by the U. S. Coast Survey steamer A. D. Bache, on a straight line, off Irvington-on-Hudson. The ends of the course were marked by range poles

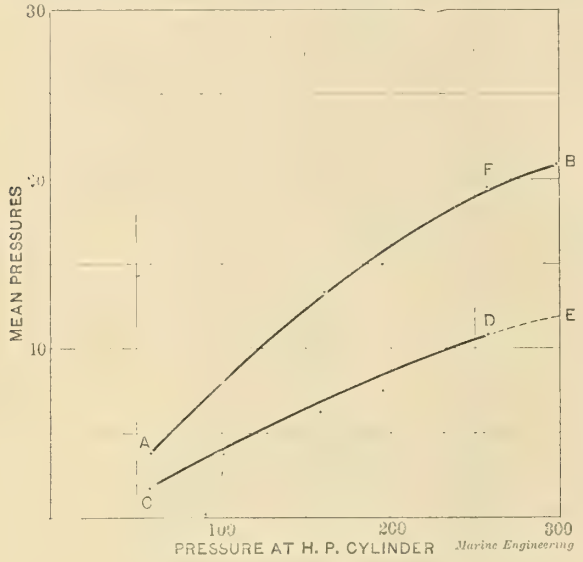


FIG. A.

on the river bank at right angles to the course. On each run the speed of the boat was adjusted by the throttle valve and the steam pressure maintained as nearly uniform as possible. The judges in the forward cock-pit took the time

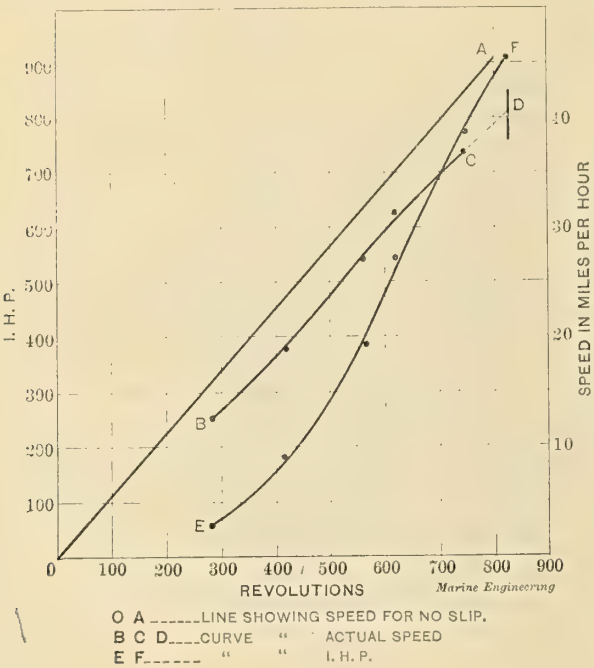

I. H. P.
REVOLUTIONS
SPEED IN MILES PER HOUR
Marine Engineering
O A ------LINE SHOWING SPEED FOR NO SLIP.
B C D----CURVE " ACTUAL SPEED
E F------ " " I. H. P.

FIG. B.

with stop watches, and by a single stroke of the bell at the beginning of the mile signaled the engine room, where indicator cards were taken, and the steam pressure and revolutions were recorded. On each of the runs over the course, indicator cards were taken from each of the cylinders, and the revolutions were taken by a special speed indicator connected to the shaft of the engine. The indicators used were specially designed by Mr. Mosher for extreme high

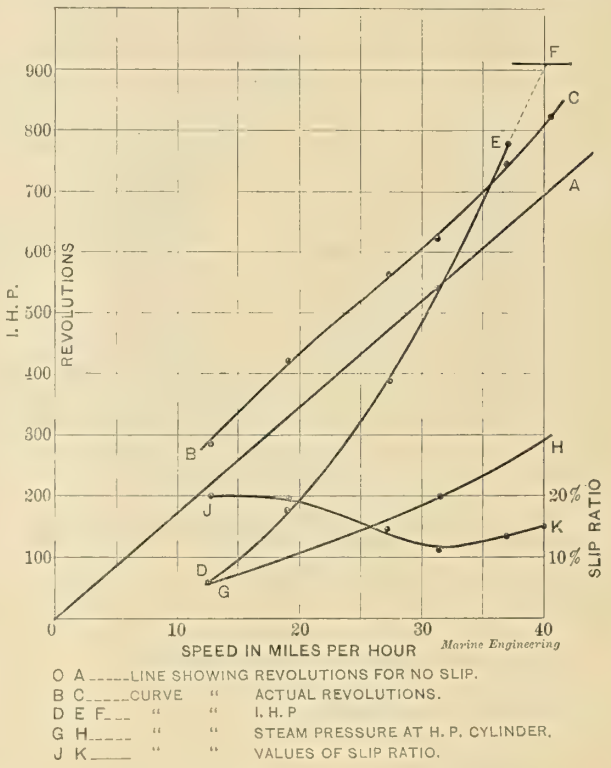

I. H. P.
REVOLUTIONS
SLIP RATIO
20%
10%
SPEED IN MILES PER HOUR
Marine Engineering
O A -----LINE SHOWING REVOLUTIONS FOR NO SLIP.
B C-----CURVE " ACTUAL REVOLUTIONS.
D E F--- " " I. H. P
G H----- " " STEAM PRESSURE AT H. P. CYLINDER.
J K---- " " VALUES OF SLIP RATIO.

FIG. C.

speeds, and were made under his direction by the Crosby Steam Gauge Co.

A selection of the cards taken is shown on page 6, together with the steam pressures, revolutions and other data relating to the power. It is proper to state, however, that all of the cards here reproduced were not taken on the same date, though the load on the boat and other conditions were practically the same on all the trials. The actual length of the original indicator cards is about 1 1-2 inches, this small size being necessary in order, at the high revolu-

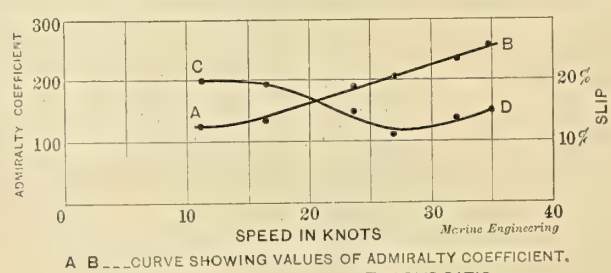


FIG. D.

tions, to avoid undue effects due to the inertia of the indicator drum.

The appearance of the boat in the water and the nature of the wave disturbance is shown in

the several engravings on pages 1 and 7 showing the results for varying speeds from medium to the highest attained. Due to the form of the boat the entrance lines become finer and finer as the bow continues to rise out of water, while due to the breadth and form at the stern there is no settling or squatting at any speed. It further follows that as the bow rises the run or buttock lines continue to become more nearly horizontal, so that at the highest speeds the after body is in large part simply sliding along nearly parallel to the surface of the water.

Discussion of Results.

Of the various indicator cards taken, all are apparently well formed and correspond to normal conditions, with the exception of one, the L. P. card, at the highest speed. There was evidence of water in the cylinder at the time this card was taken, and its influence is plainly shown in the form of the card with diminished area and rounded corners. In order, therefore, to obtain the I. H. P. at this speed it becomes necessary to apply a correction to this card, so as to obtain as nearly as possible the mean effective pressure which would have been obtained without water in the cylinder. To this end we have plotted in Fig. A the series of mean effective pressures from the second intermediate cards, on the H. P. valve chest pressures as abscissæ. This gives the curve A B. We next plot similarly the mean effective pressures from the L P cards, omitting that for the highest speed. This gives the curve C D. Now, extending this curve according to the general law shown by both A B and C D we find a point E which must be very near the correct value for 300 lbs. pressure at the engine. The value thus indicated is about 11.8 lbs. If we should make a proportion between the pressures at 257 and 300 lbs. for these two cylinders we should have:

$$19.37 : 20.88 : : 10.78 : x$$

This gives x = 11.6 lbs. a value very near the one obtained graphically. Presumably the value 11.8 is the more reliable of the two, however, because it results from a curve which takes account of the whole general trend of the pressures, while the value 11.6 results from the use of the data at 257 and 300 lbs. only. The difference is really insignificant, and either value would doubtless be quite near the true one. In any event we may be sure that some such value is the best that can be determined from the data in its existing condition. Using, then, the value 11.8 for the L P card at this speed we derive for the I. H. P. in this cylinder 223, and for the total I. H. P. 910.

Next, with regard to the speed data we find a further deficit in the absence of the speed for this power. This was due to a momentary derangement of some of the auxiliary machinery just before the runs were completed, causing the loss of the speed data at this power. Both revolutions and indicator cards were, however, taken, and by a proper use of the results as a whole the deficit may practically be made good. This may be accomplished in several ways.

In Fig. B O A gives the relation between speed and revolutions for no slip. B C gives the relation between actual speed and revolutions so far as completely determined. For the last condition we know simply that the revolutions were 822, and extending the curve B C, taking account of its general trend, we find a point D indicating a speed of slightly over 40 miles per hour, as corresponding to 822 revolutions per minute. In this diagram E F gives the I. H. P. plotted also on revolutions as abscissæ.

Again, taking the values of the I. H. P. and plotting them on the observed speeds, we have the curve D E, Fig. C. Taking the highest value of the I. H. P. as 910, and extending the curve in accordance with its general trend, we find similarly a point F, indicating also a speed of 40 miles, or slightly over, as the value corresponding to 910 I. H. P.

Both of these methods indicate substantially the same results, and it would appear that with reasonable assurance we may take the higher speed as 40 miles or 34.73 knots, and the others as observed.

In Fig. D we have plotted on speed in knots as abscissa, the values of the slip ratio and of the Admiralty co-efficient. The latter is derived from the equation:

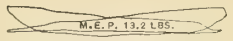
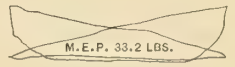
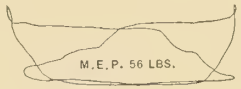
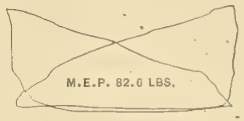
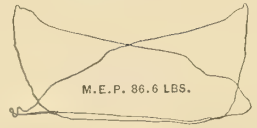
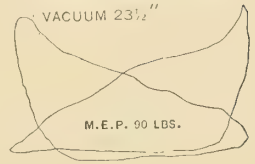
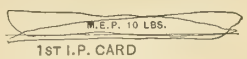
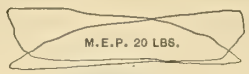
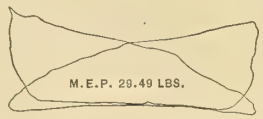
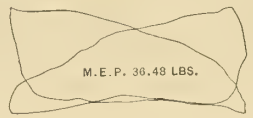
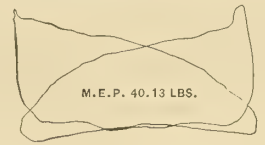
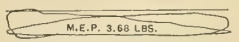
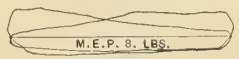
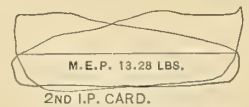
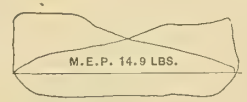
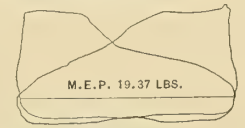
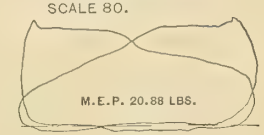
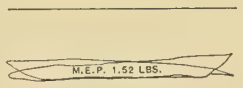
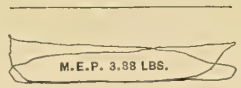
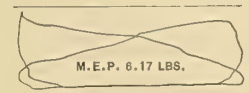
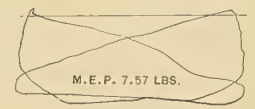
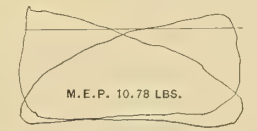
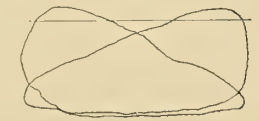
$$K = \frac{D^{2/3}\, v^3}{I.H.P.}$$

D being the displacement in tons and v being the speed in knots.

These valves, as determined, steadily increase from the lowest to the highest speeds. The lowest values are smaller than we might expect, while for higher speeds the values are correspondingly larger. The explanation of these peculiarities is perhaps to be found in the fact that the final results were attained after trying six different propellers, the one finally selected proving itself superior for the highest speeds, but relatively inferior for the lower speeds. We may therefore assume a condition of relatively low propulsive efficiency at the lower speeds, rising continuously as the speeds increase, with a corresponding decrease in the I. H. P. required relative to the cube of the speed, and a corresponding increase in the value of the coefficient *K*. It may also be observed that the indicator has of late years been suspected of under indicating the pressures at excessively high revolutions, and of thus giving a lower power than may really be required.* This would also tend in the same general direction, and the combined effect of these tendencies may serve to account, at least in part, for the values of *K* as determined. Also the lifting of the boat bodily from the water at these extreme speeds, and the consequent decrease of displacement and wetted surface, doubt-

* See Journal American Society Naval Engineers, 1895, p. 715.

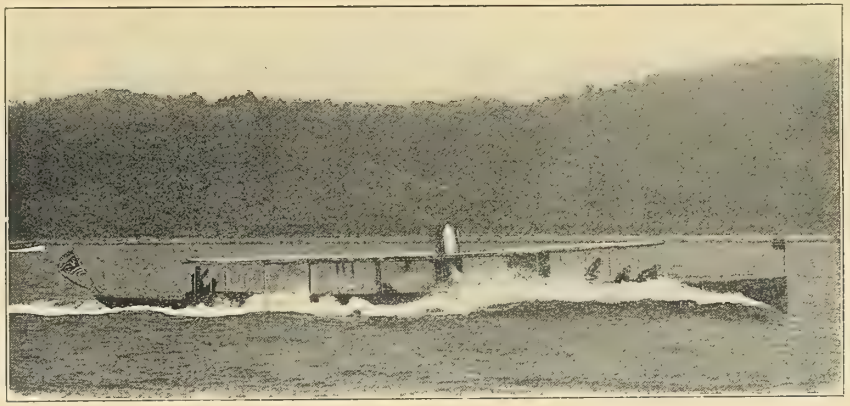
INDICATOR DIAGRAMS FROM QUADRUPLE-EXPANSION ENGINE OF THE STEAM YACHT ELLIDE.

RUN No. 1	RUN No. 2	RUN No. 3	RUN No. 4	RUN No. 5	RUN No. 6
BOILER PRES. 160 LBS. REVOLUTIONS 285 VACUUM 21½″	BOILER PRES. 165 LBS. REVOLUTIONS 418 VACUUM 23″	BOILER PRES. 180 LBS. REVOLUTIONS 560 VACUUM 23″	BOILER PRES. 285 LBS. REVOLUTIONS 620 VACUUM 23″	BOILER PRES. 320 LBS. REVOLUTIONS 748 VACUUM 23½″	BOILER PRES. 390 LBS. REVOLUTIONS 822 VACUUM 23½″
					
HIGH PRES. CARD. HORSE-POWER 15.75 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 44.58 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 100.75 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 164.54 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 208.12 SCALE 200.	HIGH PRES. CARD. HORSE-POWER 237.69 SCALE 200.
					
1ST I.P. CARD HORSE-POWER 19.08 SCALE 80.	1ST I.P. CARD. HORSE-POWER 56.04 SCALE 80.	1ST I.P. CARD. HORSE-POWER 110.74 SCALE 80.	1ST I.P. CARD. HORSE-POWER 151.61 SCALE 80.	1ST I.P. CARD. HORSE-POWER 201.23 SCALE 80.	1ST I.P. CARD. HORSE-POWER 229.2 SCALE 80.
					
2ND I.P. CARD. HORSE-POWER 13.47 SCALE 40.	2ND I.P. CARD. HORSE-POWER 43.97 SCALE 40.	2ND I.P. CARD. HORSE-POWER 95.54 SCALE 40.	2ND I.P. CARD. HORSE-POWER 118.78 SCALE 40.	2ND I.P. CARD. HORSE-POWER 186.22 SCALE 40.	2ND I.P. CARD. HORSE-POWER 220.69 SCALE 40.
					
LOW PRES. CARD. HORSE-POWER 9.89 SCALE 20. TOTAL H.P. 58.19 SPEED 12.7 MILES.	LOW PRES. CARD. HORSE-POWER 35.03 SCALE 20. TOTAL H.P. 179.62 SPEED 19.05 MILES.	LOW PRES. CARD. HORSE-POWER 78.97 SCALE 20. TOTAL H.P. 386. SPEED 27.3 MILES.	LOW PRES. CARD. HORSE-POWER 107.63 SCALE 20. TOTAL H.P. 542.56 SPEED 31.2 MILES.	LOW PRES. CARD. HORSE POWER 183.36 SCALE 20. TOTAL H.P. 778.93 SPEED 37. MILES.	LOW PRES. CARD. SCALE 20. *Marine Engineering*

FOR INSTANTANEOUS PHOTOGRAPHS OF THE STEAM YACHT ELLIDE TAKEN AT CORRESPONDING SPEEDS SEE OPPOSITE PAGE.

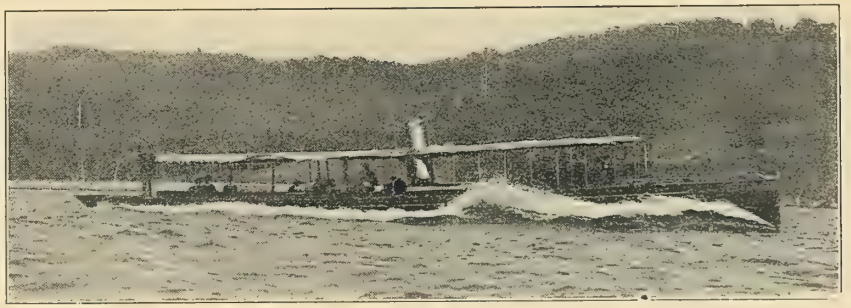
RUN NO. 1.—SPEED 12.7 MILES.

RUN NO. 2.—SPEED 19.05 MILES.



RUN NO. 6.—SPEED 40 MILES.

RUN NO. 4.—SPEED 31.2 MILES.



RUN NO. 5.—SPEED 37 MILES.

INSTANTANEOUS PHOTOGRAPHS OF THE STEAM YACHT ELLIDE GOING OVER THE MEASURED MILE ON THE HUDSON.—TAKEN BY JOHNSTON, N.Y.

less decrease relatively the resistance and power required, so that we have here an additional reason for the relatively high values of the coefficient under these extreme conditions. Similar results have been found for many recent high speed boats, so that the tendency toward a relatively high efficiency under extreme conditions (at least as measured by the steam engine indicator) may be considered as entirely normal, and as a result naturally arising from the interaction of all the special features going to make up the condition as a whole.

In connection with the results for the Ellide the data given in the table on this page relating to several recent fast boats of various types, as given in the published accounts of their trials, may be found of interest. The relation of a boat to the wave formation about it, and to the general problem of resistance and propulsion is usually considered to be the same for similar forms at corresponding speeds, or at speeds in the ratio of the square roots of the lengths. As a problem in propulsion, therefore, it becomes more and more difficult to attain high speeds, and requires a continually increasing proportion of I. H. P. to displacement, as the length and displacement are smaller. As showing, therefore, the relation of these various results to the general problem of propulsion, a comparison may be made of the various speeds all reduced to the "corresponding" speeds for a standard length, as, for example, 100 ft. These speeds are given in the next to the last column of the table.

In conclusion, the writer would state that he had on one occasion the pleasure of being on board during trials of the Ellide, and while on that occasion the roughness of the water made it inadvisable to run the boat at the highest speeds, yet the ease and moderate steam pressure with which speeds up to about 30 miles per hour were attained, furnished every evidence of abundant capacity to do all that the trials herein reported seem to indicate.

PERFORMANCES OF VARIOUS HIGH SPEED BOATS REDUCED TO A COMMON BASIS OF COMPARISON.

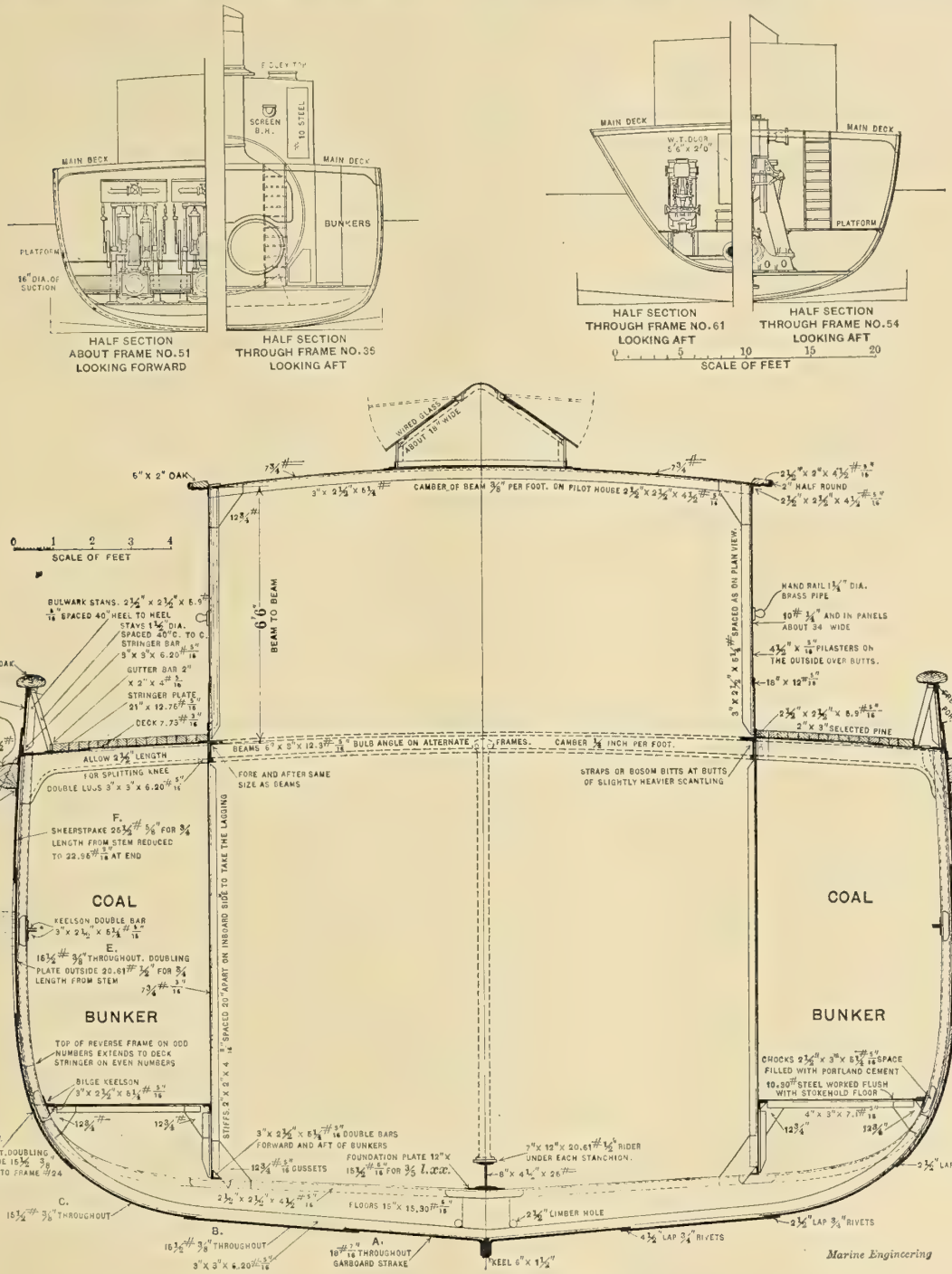
Name.	Length.	Displacement.	Indicated Horse Power.	Speed in Knots.	Speed in Miles.	Corresponding Speed in Miles for Length of 100 Feet.	Builder.
Areite	147.50	125	1,626	26.00	29.94	24.65	Thorycroft, England.
Nibbio	151.66	130	2,200	26.80	30.86	25.07	Schichau, Germany.
Cushing	137.50	105	1,650	22.00	25.33	21.60	Herreshoff, United States.
Falke	135.00	88	1,400	24.02	27.65	23.81	Yarrow, England.
Chevalier	144.00	118	2,700	27.22	31.34	27.08	Normand, France.
Hornet	180.00	220	4,000	28.00	32.24	24.03	Yarrow, England.
Adler	152.00	150	2,300	27.40	28.09	25.54	Schichau, Germany.
Boxer	205.50	250	4,487	29.17	33.59	23.42	Thorycroft, England.
Daring	185.00	229	4,700	29.26	33.70	24.78	Thorycroft, England.
Sokol	190.00	240	3,900	29.77	34.28	24.88	Yarrow, England.
Desperate	208.00	272	5,400	31.02	35.73	24.78	Thorycroft, England.
Forban	144.40	125	3,200	32.03	36.88	30.70	Normand, France.
Hart	194.00	245	4,143	27.00	31.00	22.32	Fairfield Co., Scotland.
Sunfish	200.00	290	4,500	28.05	32.30	22.84	Hawthorne, Leslie & Co., Eng.
Starfish	190.00	252	4,510	28.00	32.20	23.37	Naval Con. Co., England.
Bathurst	130.00	85	1,230	24.42	28.12	24 66	Yarrow, England.
Vamoose	112.50	66	800	19.55	22.50	21.22	Herreshoff, United States.
Porter	175.00	180	3,500	28.74	33.09	25.01	Herreshoff, United States.
Turbinia	100.00	44	2,100	32.75	37.71	37.71	C. A. Parsons, England.
Feiseen	85.00	16	590	27.43	31.60	34.27	C. D. Mosher, United States.
Norwood	63.00	9	400	26.50	30.50	38.43	C. D. Mosher, United States.
Ellide	80.00	13	910	34.73	40.00	44.72	C. D. Mosher, United States.

NEW AND POWERFUL FIRE BOAT FOR THE CITY OF CHICAGO.

A new fire boat for the city of Chicago, Ill., now under construction by the South Chicago Shipbuilding Co., will be one of the most powerful vessels of her type afloat. In the various drawings of the boat which we here publish the chief features of design and construction can be plainly noted. The Chicago Fire Department, one of the most efficient in this country and consequently in the world, has had much experience in the use of this class of vessel. The new vessel, therefore, embodies not only the most modern ideas in its character as a ship, but also is strictly up-to-date with respect to its fire fighting capacity. Plans for the vessel were drawn for the department in the office of A. W. Goodrich, of Chicago, and the contract was let last summer to the Chicago Shipbuilding Co., for $68,500, the price being for the boat, ready for service, excepting brass work, such as scuttles, timber heads, fairleads, etc., and all hose and appurtenances for fighting fire, which are supplied by the Fire Department.

The duty to be performed by a fire boat in the port of Chicago called for many special features of design and construction, for no mere floating pumping station would suffice for the exacting work there. The Chicago river, in both its north and south branches, along which lie extensive manufacturing plants, lumber yards and other dangerous risks, is a tortuous narrow stream. The traffic is heavy and consequently a boat which was intended to move quickly up or down stream should be extremely handy, susceptible to the influence of her rudder, and sufficiently strong not to be easily damaged by contact with vessels or wharves. Then during the long and severe winters much heavy ice is encountered, not only in the river but in the harbor, and as wharf fires in South Chicago are not uncommon, the heavy ice floes of Lake Michigan would have

to be bucked in running down the lake, between Chicago and Calumet rivers. The new boat is

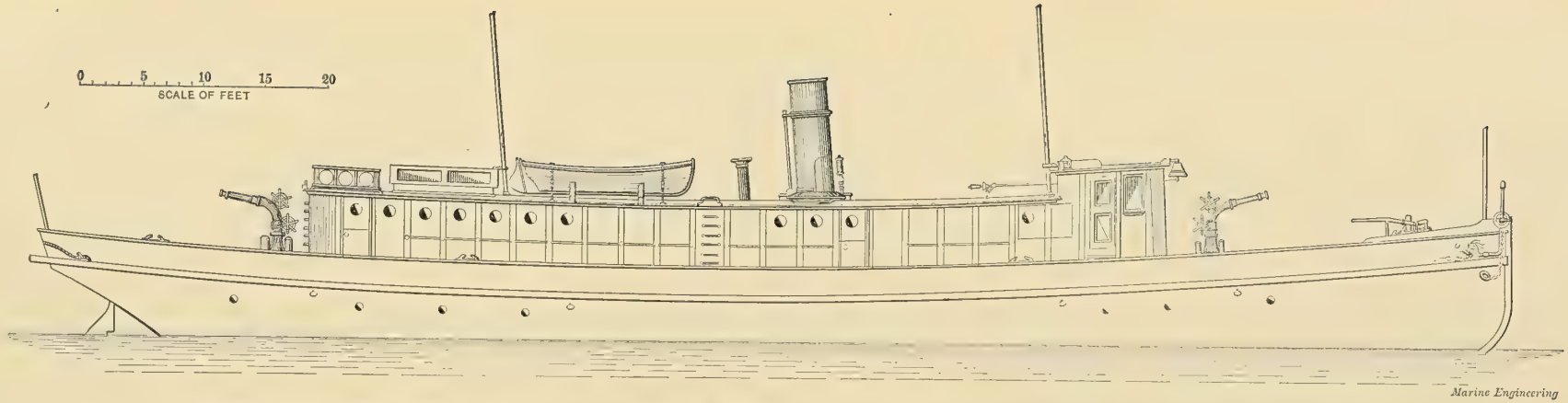


CROSS SECTIONS OF THE FIRE BOAT ILLINOIS FOR CHICAGO, ILL.

built of Siemens-Martin steel and is of these dimensions:

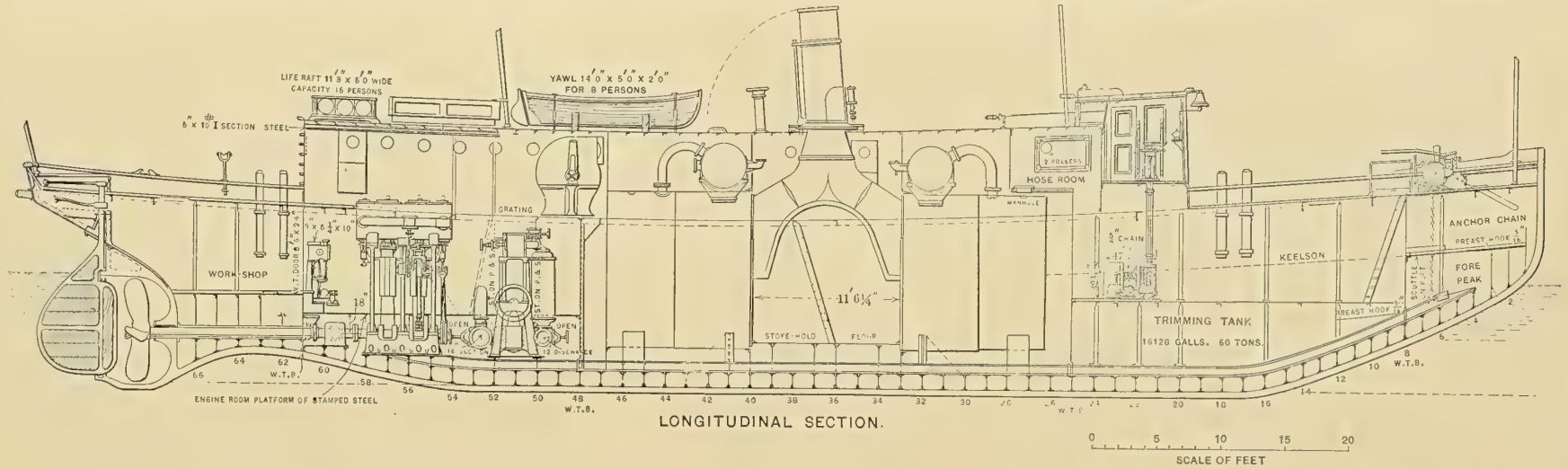
Length over all	118 ft.
" bet. perps	107 ft.
Beam molded	24 ft.
Depth hold	11 ft. 9 in.
" molded	12 ft. 6 in.
Draught	9 ft.

The hull is very thoroughly subdivided, having four athwartship water-tight bulkheads, a water-tight deck fore and aft forward, over the trimming tank, and in addition to these the coal-bunkers are carried along the sides in the boiler room. A bar keel, 6 in. by 1 1-2 in., is fitted and the skin plating is worked on in inside and outside strakes with vertical seams butt strapped. As shown in the profile the keel forward is carried in an easy sweep above the load water line, the forefoot being cut away considerably so that

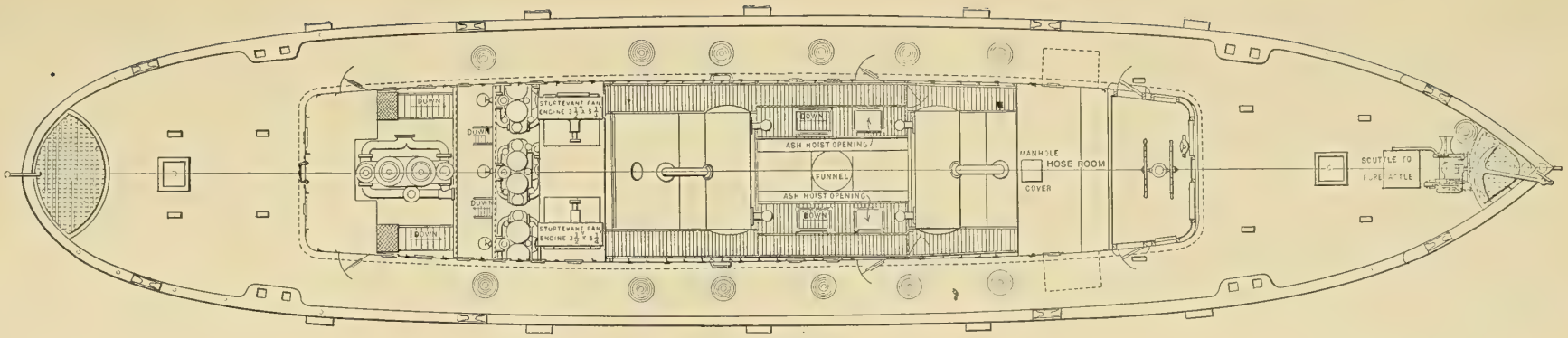


FIREBOAT ILLINOIS FOR CHICAGO, ILL., BUILT BY THE CHICAGO SHIPBUILDING CO., SOUTH CHICAGO, ILL.

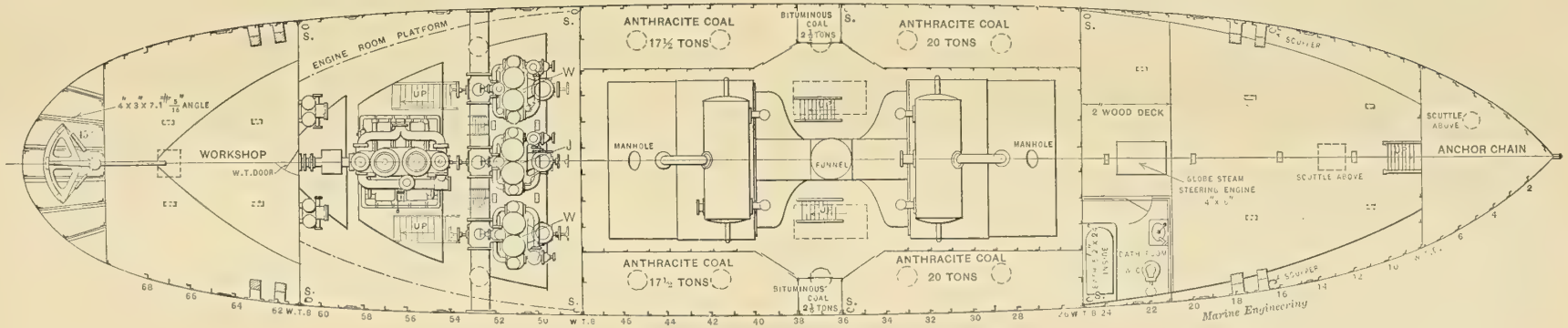
the boat can get on the ice easily and break it away. At the after end of the fireboat the keel is carried upwards in front of the propeller, giving a shallow draft here and enabling the boat to swing quickly in a short radius. The stem is of steel 6 in. by 1½ in. and the stern post and rudder post is cast steel in one piece 5 1-2 in. molded by 3 1-2 in. sided. The rudder is of large dimensions with iron frame forged in one piece, with stock 6 in. dia. at head and 4 in. at heel and pintle. It is filled in with white pine and rosin and plated with 10 lb. steel. The pintles are steel with metal sleeves turning in lignum vitæ bushings in the pintle hole in the rudder post, and the weight of the rudder is carried inside the hull by a collar on the rudder head, moving in a brass disk secured to a cast iron water-tight support. Dimensions of the hull material will be found on page 13.


LIFE RAFT 11'3" x 5'0" WIDE CAPACITY 15 PERSONS
YAWL 14'0" x 5'0" x 2'0" FOR 8 PERSONS
6" x 10" I SECTION STEEL
WORK SHOP
GRATING
HOSE ROOM
2 ROLLERS
MANHOLE
KEELSON
ANCHOR CHAIN
BREAST HOOK
FORE PEAK
SCUTTLE
TRIMMING TANK
16128 GALLS. 60 TONS.
STOKE-HOLD FLOOR
11'6¼"
OPEN
ENGINE ROOM PLATFORM OF STAMPED STEEL
W.T.B.
66 64 62 60 58 56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2

LONGITUDINAL SECTION.



MAIN DECK PLAN.



HOLD PLAN AND MAIN DECK OUTLINE.

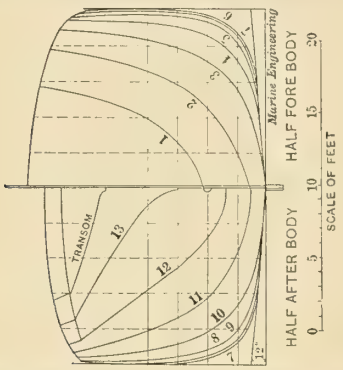
GENERAL ARRANGEMENT OF THE SINGLE-SCREW FIRE BOAT ILLINOIS FOR FIRE DEPARTMENT OF CHICAGO, ILL.

On the main deck a continuous deck house of 10 lb. steel occupies 69 ft. of the length by 14 ft. in width and rises to a height of 6 1-2 ft. at the side. In the forward end is the pilot house, finished in mahogany, with hardwood floor and the usual navigating apparatus. The steering wheel is connected by gears and a vertical shaft with a Globe Iron Works steam steerer below on the lower deck. The sides and roof of the pilot house are carried above the deck house level to give sufficient head room. Aft of the pilot house there is a hose room extending partly over the forward boiler in the boiler room. The engine and boiler trunks take up all the remainder of the deck house. On top of the house there is a yawl and patent raft, and a skylight with protected glass over the engine room. Below, the chain locker is located in the extreme forward end over the fore peak. It is constructed of 3-in. plank. Communication with the forecastle is had from the main deck by an oak ladder. This compartment is fitted with hooks and can be used for firemen's clothes. Just forward of the machinery spaces on the lower deck is the steam steerer, before referred to, and to the starboard side a water closet and lavatory. This is piped with hot and cold water in bath tub and wash bowl, and all the fittings are of the very latest sanitary model. The room is finished in white gloss paint with tiled floor. Next, the boiler

and engine rooms take up the greater portion of the boat's length. Aft of the engine room there is a workshop between decks with benches and vise. There are two air ports and four deck lights in this room, and a small square brass scuttle with rollers fitted in the main deck for taking hose through. Communication with the workshop is had through a water-tight door in the engine room.

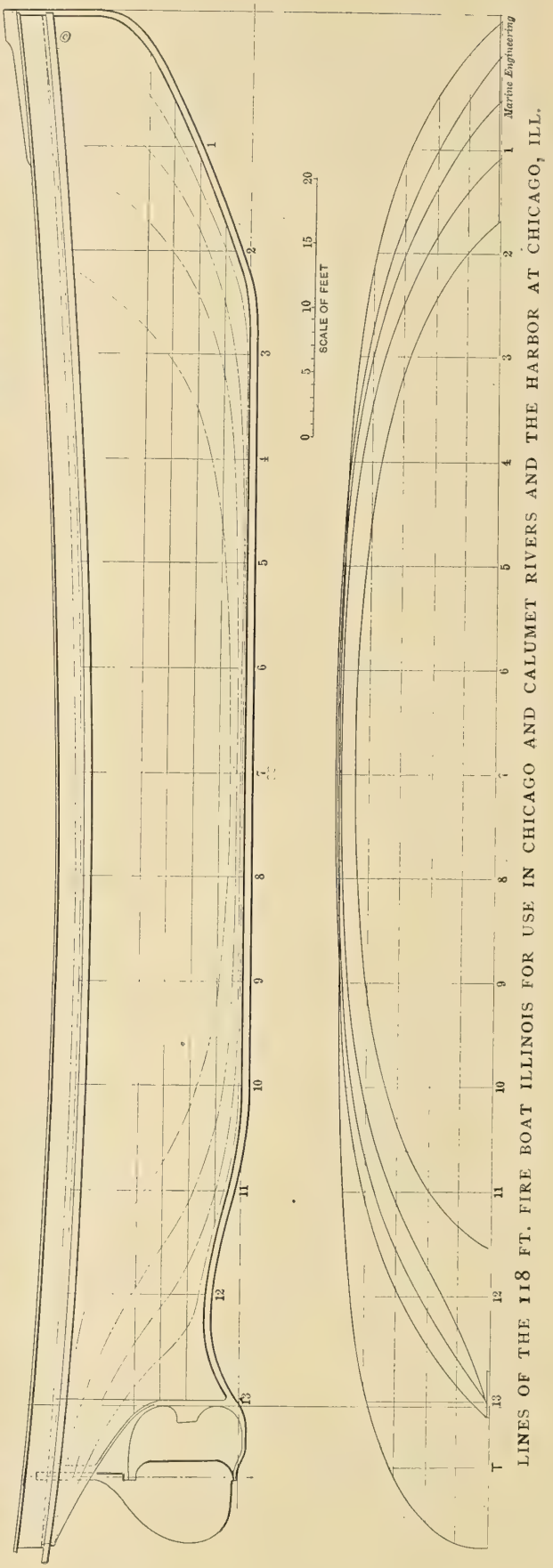
In the way of deck appliances the boat has a steam windlass on the forecastle, built to work a 1-in. chain on the starboard side and a heavy mooring warp on the port side. An anchor davit with all necessary tackle is so arranged that when not in use it can be lashed on deck under the anchor grating. An anchor weighing about 700 lbs. and 25 fathoms of 1-in. close link chain will be supplied. There is a complete equipment of bitts, chocks, cleats, fair leaders, and timber heads. Ample runways and special deck scuppers are provided to rapidly carry overboard all surplus water. A low steel bulwark of 10-lb. plate is carried all around, with top rail of 9-in. by 3-in. seasoned oak.

A minimum amount of wood work is used in



the construction for obvious reasons. The main deck is planked with 2-in. Michigan pine and the lower deck is similarly laid and calked. Over the forecastle companion-way there is a flat top hatch, 29 in. by 32 in. finished in mahogany and brass hardware. This is surrounded on three sides by a white metal guard rail 30 in. high, entrance to the hatch being on the fore side only. A jackstaff at the bow and flagstaff at the stern are fitted and two tall flagstaffs on the top of the deck house as indicated in the profile, page 10.

The propelling engine is of the vertical inverted two-crank, high-pressure type, driving a single screw. The two cylinders are 20 in. dia. and 20 in. stroke, to work with boiler pressure of 140 lbs. They are carried on rear columns of cast iron and front columns of wrought iron turned. The bed plate is cast iron of box girder section with three main journals 10 in. long. The connecting rods are wrought iron 4 ft. 6 in. between centers, 4 in. dia. at the upper neck, and 4 1-2 in. at the lower, with upper ends forged solid and eyes slotted out. Cast steel is used for the crossheads, which are fitted with brass slippers and pins 5 in. dia. and 3 in. long. The



LINES OF THE 118 FT. FIRE BOAT ILLINOIS FOR USE IN CHICAGO AND CALUMET RIVERS AND THE HARBOR AT CHICAGO, ILL.

pistons are "semi-steel" and the rods forged steel 4 1-2 in. dia. They are tapered in the pistons and secured with a nut, and also tapered in the cross-heads and there keyed. Stephenson double-bar link motion is used, with cast iron eccentrics, wrought iron rods, steel valve stems and hard brass link blocks. These are fitted with adjustable gibs. Hammered iron is used for the crank shaft, which is 8 in. dia., with couplings forged on, and also for the pins, the crank slabs being of cast steel. The thrust and line shafts are both of iron 8 in. dia.

Cast steel is the material used for the propeller. It is four bladed, 8 ft. dia. and 10 ft. true pitch, made extra heavy and modeled so as to give fair efficiency when backing.

Auxiliaries include two Worthington Admiralty type duplex pumps placed against the after bulkhead of the engine room. These have cylinders 9 in. by 5 1-4 in. by 10 in., and are for boiler feed chiefly. A Worthington duplex sanitary pump with cylinders 4 1-2 in. by 2 3-4 in. by 4 in. is also included, with both sea and fresh water connections. Communication between the pilot house and engine room is by Cory mechanical telegraph.

Forward of the propelling engine in the same compartment is a set of fire pumps, consisting of three double acting, vertical, single, duplex, crank and flywheel pumps. The steam cylinders are 17 in. dia. and 11 in. stroke, of cast iron with piston valves. The pump ends are composition, with water cylinders 10 in. dia. and 11 in. stroke. Each pump is to have a minimum capacity of 3,000 gallons a minute, with a pump pressure of 170 lbs. per sq. in., the steam on the boilers not being less than 125 lbs. The pumps are designed with large free passages and valves and large suction and air chambers. The running parts are steel and the pump rods Tobin bronze. The weight of the three pumps and necessary appliances is limited to 40,000 lbs. They were built by the American Fire Engine Co., of Seneca Falls, N. Y.

Connecting with the set of pumps there are two 10-in. circuit pipes running along the sides just below the main deck and coming together just forward and abaft the deck house in two stand pipes shown in the outboard profile. These stand pipes are fitted with adjustable nozzles and when in operation will be capable of sending solid streams of water a tremendous distance from the boat with force sufficient to demolish any ordinary brick wall. At intervals along the sides of the deck house there are valves and hose connections with these pipes protected by steel boxes.

There are two single-ended return-tube boilers 12 ft. dia. and 11 ft. long, fitted front to front with an athwartships fire room between. Each has a steam drum crosswise of the boiler, 42 in. dia. and 9 ft. long. Each boiler has two Morison furnaces 48 in. dia. by 8 ft. 5-8 in. long and has separate combustion chambers, 29 in. wide at bottom and 26 in. wide at top, with a 6 1-2 in. water space between chambers. There are 228 tubes, 2 3-4 O D, 8 ft. 2 in. long and 11 B. W. G. thick. The boilers are built of 60,000 lb. marine steel to withstand a working pressure of 140 lbs. Each boiler has a breeching of No. 8 steel connecting with the funnel which is common to both. The funnel is 36 in. dia., of No. 10 steel, and is hinged so that when passing under river bridges it can be promptly lowered. There is an arrangement for forced draft, two direct driven Sturtevant steel plate fans being fitted over the fire pumps in the engine room, as shown in the section on page 10. These are driven by engines 3 1-2 in. by 5 1-4 in. and have a capacity of 16,850 cu. ft. per minute. The boilers are fitted with the necessary air tight doors and dampers for use when working with forced draft.

For lighting the vessel there is one electric direct connected set supplying current for 100 16 C.P. lamps. Ash hoists are fitted on each side of the stroke hold.

Severe tests of all material were imposed and in general construction the new boat conforms to Lloyd's rules for first-class steel vessels. She was built under the supervision of Naval Architect W. J. Wood, of Chicago, acting as representative of the Fire Department, and was recently christened the Illinois. We take pleasure in acknowledging the courtesy of the Chicago Fire Department in furnishing us with data and drawings, used in the preparation of this description.

Data for Hull Construction of Fire Boat Illinois for Chicago Fire Department.

SCANTLING.

Frames 3 in. × 3 in. × 6.20 lb. — $\frac{5}{16}$ in. spaced 20 in. apart heel to heel.
Frames spaced 16 ft. apart for about 20 ft. abaft stem.
Double frames on all Watertight Bulkheads.
Reverse frames 2½ in. × 2½ in. × 4½ lb. — $\frac{5}{16}$ in. extending to Deck stringer plate and to 12 in. above upper bilge stringer alternately.
Floor plates 15 in. × 12¾ lb. — $\frac{5}{16}$ in. and 15 in. × 15.30 lb. — $\frac{5}{16}$ in. in Eng. and B. space.
Keel and Stem 6 in. × 1½ in. Scarphs 18 in.
Stern frame 5½ in. × 3½ in. Scarph 32 in.
Rudder head 6 in. dia., heel and pintle 4 in. dia.
Rudder plating 10 lb. per foot, ¼ in. bare.
Bulkhead plating 10.30 lb. — ¼ in. Stiffs. 3 in. × 3 in. × 5 lb. — ¼ in.
Coal Bunker Bulkhead plating 7¾ lb. — $\frac{3}{16}$ in. width.
Stiffeners of angle bar 2 in. × 2 in. × 4 lb. — $\frac{5}{16}$ in. spaced 20 in. apart.
Solid Hold Stanchions 3 in. dia. wherever possible.
Screen Bulkheads on Circumference of Boilers, No. 10 B.W.G. — 5.45 lb.
Angle steel stiffeners 2 in. × 1⅜ in. × 2.1 lb. — $\frac{3}{16}$ in. laid diagonally.

BUTTSTRAPS AND RIVETING.

Shell plating single riveting longitudinally 2½ in. laps, ¾ in. rivets. Buttstraps 9¾ in. wide and $\frac{7}{16}$ in. thicker than the plates they connect and double riveted throughout.
Sheerstrake and Garboard strakes double riveted, laps 4½ in. wide, ¾ in. rivets. Buttstraps of Sheerstrake to be worked up to Bulwarks, thro' stringer plate.
Buttstraps of Deck stringer 11¾ in. wide and treble riveted with ⅞ in. rivets, Straps on under side of stringer plate, and flush riveted on top.
Deck plating butts lapped 3¾ in. wide and treble riveted with ⅞ in. rivets, flush on top.
Deck seams single riveted 2½ in. lap ⅞ in. rivets flush above.
Bulkhead plating single riveted 2¼ in. lap ⅞ in. rivets finished with snap tool button points.
Floors double straps, 14¼ in. × 10.3 lb.— ¼ in. treble riveted ¾ in. rivets.
Where thicknesses and weights of material differ, take weights.

SUBMARINE TORPEDO BOATS: THEIR INFLUENCE ON TORPEDO BOAT ARCHITECTURE AND VALUE IN WARFARE.*

BY CAPTAIN WILLIAM H. JAQUES.

Although actual warfare may be the only definite means of establishing the value of new developments in naval architecture, it is too expensive a means to depend upon, and the awaiting of its solution would subject us to the enormous disadvantage of want of preparation and proper insurance which demand an earlier decision upon the questions involved.

Fortunately, the peace and prosperity of the great nations have not been disturbed frequently enough by war to secure their dictum that the generally accepted type of torpedo boats is one which has not come to stay; but there is evidence enough in the results that obtained in the late Japan-China war; in the discomfort of life on board; in the accidents incident to manœuvering; their unfitness for serious work at sea; the great fatigue to which the crews are subjected; and the marked strides in torpedo boat construction to reach speed, protection and a reasonable defensive power to convince us that the present torpedo craft, whether she be carried on a battleship or is a torpedo boat destroyer, is neither sufficiently protected nor invisible, nor can she keep the seas without ruining her personnel.

The torpedo boat experience gained in the Japan-China war especially demonstrated the fact that the ordinary torpedo boat had more defects than enduring or reliable qualities, and there is abundant evidence, certainly, to suggest, if not convince, that there must be some radical change in the present torpedo boat architecture.

The desire or attempt to produce a submarine boat for war purposes is not by any means new, nor have the controlling elements of design been restricted to one principle, except in the Holland system, with which John P. Holland has for so many years been directly associated.

It must not be forgotten that some of the leading and most generally accepted principles of the present battleship were taken from the American monitor, a type that for many years was practically discarded, but which during the United States Civil War in the crisis of 1861 accidentally but completely—and practically against the ideas of the naval officials—gained such a decisive and remarkable victory as not only to largely influence the course and conclusion of the Civil War, but to impose conditions on subsequent naval architecture that have been universally accepted. And this victory was gained directly in the face of the most intense opposition of naval officials. If the late monitor had not had the opportunity of war to prove her value, it is extremely doubtful if she would ever have had such an important place in naval history or naval architecture.

* A paper read at the Thirty-ninth Session of the Institution of Naval Architects, London.

All treatises on torpedo-boats, all reports in connection with their construction and supply, all references to their achievements, emphasize, more or less, the requisite of invisibility and power to reach an enemy, and to successfully get torpedoes into an enemy's ship.

The development of the submarine boat, its power to disappear, its ability to move quickly, its valuable element of submergence, the practicability of protecting by armor, its limited visible portion, and the surety of its fish-like qualities, must have a radical influence in modifying the present types of torpedo craft, no matter whether it replaces the second-class torpedo-boat on board a battleship, whether it is employed for submarine purposes pure and simple, or, as most probably will be the case, its submarine principles are utilized to protect the semi-submerged torpedo-boat and to meet the practical conditions sought for in combining such invisible and protective qualities as will enable the torpedo-boat to surely get in her work.

EARLY SUBMARINE BOATS.

The literature of the early history of submarine navigation is, more or less, familiar to all, and while nearly all of the experimental boats, even those of the seventeenth century, have thrown some light on the subject, the "Plongeur," the Nordenfeldt boats, those of the Goubet type, those of the Alexandrofsky principle and the "Holland" have received the most prominence and attention. In these all sorts of mechanical contrivances and powers—compressed air, electricity, petroleum and reservoired heat—have been separately or collectively employed. It is by a careful study of what has been done in these types, and of what has caused their failures, added to the benefits and advantages which industrial development has provided in mechanics, metallurgy and electricity, that we are able to present to-day a craft built on the vital Holland principles, which we believe will be not only of great value to naval architecture, but of great usefulness in war, and which will have a powerful influence in the removal or reduction of the defects of the present torpedo-boat.

FOUR ORIGINAL HOLLAND BOATS.

Before describing the two submarine boats, the "Plunger" and the "Holland," now receiving so much attention in the United States, let me say a few words about the four boats built under Mr. Holland's direction, and in and with which he made the experiments that made his final success possible.

Boat No. 1 was built in 1877 by the Albany City Iron Works, of New York. Her dimensions were 14 ft. 6 in. long; 3 ft. beam, and 2 1-2 ft. deep; she had a double body, the inner one being cylindrical; water space between them. She was operated by a 4 H. P. petroleum engine with one screw, and had vertical and horizontal rudders.

Mr. Holland experimented with this boat for nine months, and, although her petroleum engines were a failure, and the speed was very unsatisfactory, he proved that he could submerge her at will and keep her under water, and determined that the horizontal rudders were useless when placed in the transverse axis, but effective when at the stern.

After he demonstrated that it was possible to control the boat under water, he had the engines pulled out, and sank it under the Fall's Bridge at Paterson, N. J., where the hull now lies in the Passaic river.

Boat No. 2 was commenced in 1879 at the Delamater Iron Works, New York city. She was finished and delivered to Mr. Holland in April, 1881; he started experimenting with her immediately, and continuing until October of that year. In that boat he made most of his experiments. She was 31 ft. long; 6 ft. in diameter; 19 tons displacement, and was fitted with a 15 H. P. Brayton petroleum engine. With a crew of one engineer and himself he cruised all over the harbor of the North river. Most of his experiments were made under water. As an example of the perfect control of pressure, Mr. Holland relates that, with the boat submerged and resting on a gravel bottom, the engineer opened a bottom manhole, stepped out (without a diving suit), lifted the hull slightly with his hands, and then got in again and closed the manhole.

With her armament of a submarine gun 10 ft. 2 in. long and 9 in. bore, he succeeded in getting a perfectly straight projectile trajectory under water for about 40 yards. To fire the submarine projectile he used 200 pounds air pressure; the highest was 495 pounds, but it did not appear to make much difference in the range; 250 pounds did nearly as well. The Delamaters built the projectile. This particular pneumatic gun was made of a welded steel tube, and was the foundation for the pneumatic gun system that was afterwards developed under the management of the Pnuematic Dynamite Gun Company. This craft is now lying at New Haven, Connecticut. Her engine is still in her, but the air compressor was taken out about two years ago to run a forge.

Boat No. 3 was built at Ganning's Copper Shop, Jersey City, New Jersey, and was a working model. In her Mr. Holland first employed the apparatus for steering under water in the horizontal plane; he intended to build a gunpowder engine to propel her under water, but, before he accomplished this, she was sunk opposite Whitestone, the engineers, not understanding how to fasten the turret, having left it open about half an inch. A few experiments under water were made before the accident. She was 16 ft. 4 in. in length by 28 in. diameter, and of one ton displacement.

Boat No. 4 was known as the Zalinski boat, and was built at Fort Lafayette, of composite iron frame, planked with wood; she was 40 ft. long, 8 ft. diameter, and it was the intention to arm her with large Zalinski pneumatic guns. The launch was mismanaged, the ways broke under her, she fell on the rocks and was seriously damaged. She was repaired sufficiently to carry on experiments at the dock, where she was frequently submerged, and much information secured concerning the control of water ballast. She was finally broken up.

In all these boats Mr. Holland's fundamental principle was to dive, and not to "control" them, as in the foreign types, either by the inlet, or outlet, of water, or by down-haul screws alone.

RESULTS OF EXPERIMENTS.

The main things proved by these experiments were: That in submarine boats it was essential to have an unmovable center of gravity; that the movable center was the cause of nearly all the failures; that during the submarine run the weight must remain absolutely unchanged, being kept the same automatically, otherwise she cannot dive when you desire it, or she may run to too great a depth. Another thing demonstrated was the value of a boat that would be as small as possible, consistent with having sufficient offensive power. It must also be quick-acting, so as to be able to come to the surface and to disappear as rapidly as a porpoise. A cardinal principle governing its design is simplicity.

SUBMARINE BOAT "PLUNGER."

While there have always been naval officers in the United States who have advocated the value of submarine boats, and the Navy Department has at various periods interested itself in them, the advertisements of November 26, 1887, and May 1, 1893, called forth the most important proposals, and a contract was entered into with the Holland Company in 1895.

The one constructed by the Holland Company for the United States Navy Department was named the "Plunger" by the department, and was launched August 7 last, at the constructor's yard in Baltimore. She is the fifth one designed by Mr. Holland, and is 84 ft. long, of circular section, 11 ft. 6 in. in diameter, surface displacement 149 tons, submerged displacement 165 tons, with a reserve buoyancy of about a quarter of a ton. The guaranteed speed is 15 knots on the surface and 14 knots while awash, with 1 ft. of the turret above the water. Her totally submerged electrically running speed must be 8 knots for six hours. There is a turret amidship with 4 in. of protection and a superstructure for fair weather. Two down-haul screws have been added, although they are not considered by Mr. Holland a requisite of the system. There are two openings in the nose-piece through which service torpedoes are to be discharged. In addition to hand-gear for horizontal steering and diving, there are automatic devices for maintaining submergence at predetermined depths. A camera lucida has also been fitted. The hull has been constructed to admit a submergence of

75 feet. Some of the water-tight compartments serve as water tanks; others contain oil fuel; others are employed for compensating discharged weights. A special device compensates for the oil consumed. There are four rudders, two for steering horizontally and two vertically, controlled by automatic devices.

For running on the surface or awash, steam generated by pertoleum is employed, while electricity from storage batteries is used under water. There is one water-tube boiler of the Mosher type of 3,000 sq. ft. heating surface, fitted with a system of oil fuel capable of consuming 2,000 pounds of oil per hour. There are two main, vertical, triple-expansion steam engines of 600 H. P. each, and one auxiliary of the same type of 300 H. P.

The electric machinery is composed of one main motor of 70 H. P. for propelling the boat when submerged, operating either the side or center shaft, or used as a dynamo for recharging batteries. There are additional electric motors for operating down-haul screws and performing other services as required.

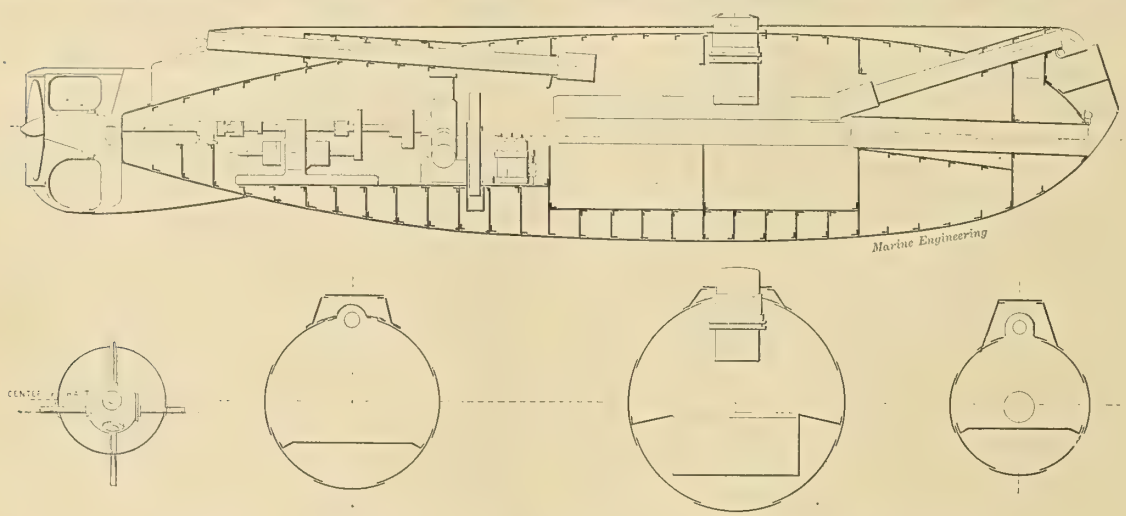
Air for tank and ventilation service is supplied from commercial reservoirs. There are special fittings for closing smoke pipe and air ducts quickly before submerging, and the tank operations are very simply controlled by Kingston and compressed air reducing valves. The "Plunger" has three propellers (in addition to the down-haul screws), any one, or all of which can be operated by either steam or electrical machinery.

DESCRIPTION OF THE "HOLLAND."

Owing to the delays incident to the many modifications of the "Plunger," constructed for the Navy Department at the Baltimore shipyard, the Holland Torpedo Boat Company decided to build a boat into which the essential elements of Mr. Holland's type could be introduced and experimented with by the company, and boat No. 6, the "Holland," was built at the Crescent Shipyard, Elizabethport, New Jersey, by Lewis Nixon. Its form resembles that of the porpoise and its dimensions are:

Length	50	ft.
Diameter	11	"
Displacement, light	119	tons.
" with superstructure awash	138	"
" submerged	139	"
Reserve buoyancy	0.7	"

In this boat no attempt was made to secure a higher speed than was necessary to secure proper diving and steering properties. It was fitted with a 50 horse power gasoline engine for surface runs, air compression and storage battery charging, and a 50 horse power electric motor for submerged work. Its armament consists of one 18 in. service torpedo tube and two dynamite guns fitted for powder and compressed air discharge. At a speed of 8 knots the "Holland" maneuvers, steers and dives beautifully, and the control of submergence is speedily and easily effected by the operation of Kingston and compressed air reducing valve. Her stability has been thoroughly proved and the atmospheric conditions when submerged are infinitely safer and more comfortable than those of the ordinary torpedo boat. From four to six men are required for her operation.



SECTIONAL DRAWINGS OF THE HOLLAND SUBMARINE TORPEDO BOAT.

ARMAMENT OF SUBMARINE BOATS.

Although the Holland Company has several designs, simple and novel, for the armament of submarine boats, in the presentation of this paper it is not intended to ask your consideration of them; for the boats themselves can be readily fitted with Whitehead or Howell torpodoes, employing powder or compressed air discharge, or with over-water projectiles fired with either powder or air or a combination of both.

FACILITIES FOR BUILDING BOATS.

If these vessels are to be supplied in large numbers; if they are to be quickly built and to become speedily available for the crises which ar-

rive to every nation, their advantages can be more readily understood when it is known that the elements of which they are composed and built are commercial products. Gas and steam engines can be secured from a hundred builders; electric motors have replaced and are as easily procurable as horses; electric storage batteries, although still far from being fully satisfactory are no longer novel and difficult to obtain; compressed air cylinders are increasing every day in strength and capacity; petroleum fuel can be carried with less danger than bituminous coal; and the parts which compose the special controlling mechanisms of the system are all marketable products, easily and quickly assembled and adjusted.

RESULTS SOUGHT IN DESIGN.

In the design and construction and practice with the Holland submarine boats "Plunger" and "Holland," we have been going on the principle of developing not a boat simply as a toy or a working model, but one which will be especially useful for the primary purpose to which a submarine boat should be put—that is, of actually fighting vessels around the harbors and on the coast, instead of in the open sea.

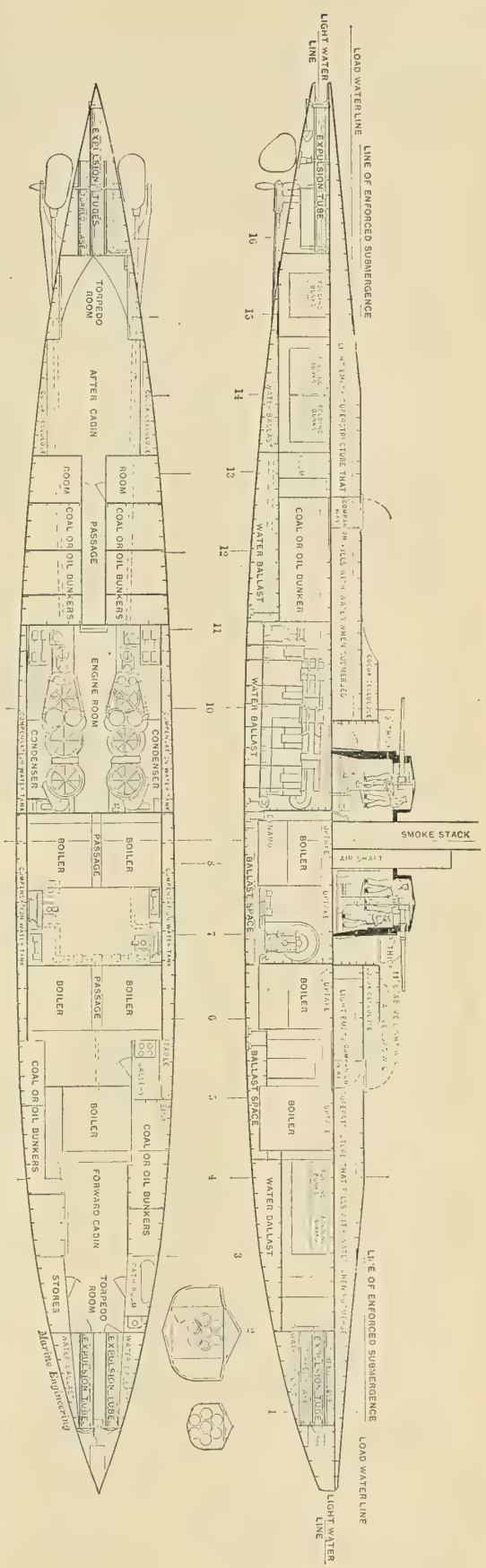
The dimensions of a submarine boat proper should be governed by the necessary offensive power, and while having in it all the destructive power desired, it should be small enough to get close up to and, practically, nibble at the bottom of the ship to be destroyed. This object appears to have been accomplished in the "Holland," for she has all the speed necessary to control her fish-like qualities, has power to disappear, can take care of herself, and, at the same time, is able to work three very powerful guns.

While this has been accomplished no doubt other valuable developments will be in the direction of small craft to take the place of second-class torpedo boats and battleships, and of semi-submerged boats of almost any dimensions, having armor enough above water to afford ample protection, at the same time protecting all the rest by water.

ARMORED SEMI-SUBMERGED BOAT.

We all know how difficult it is to adequately protect a ship with armor even by a most careful distribution of weights. The semi-submerged boat presents a type in which you can armor such parts as are necessary, employing very heavy armor, because you have reduced to a minimum the part exposed, and possessing submarine qualities it is the only kind of boat that will do this, as it is well known there is not a torpedo boat in existence to-day that will meet these conditions.

In such a craft one can get close up to a ship and fire the torpedo into her, while an ordinary torpedo boat will be simply riddled and sawed into pieces by rapid-fire ammunition. Further, a semi-submerged armored torpedo boat will be able to get so near her target that by greatly re-



GENERAL ARRANGEMENT PLANS OF PROPOSED SEMI-SUBMERGED ARMORED TORPEDO BOAT DESCRIBED IN CAPT. JAQUES' PAPER.

ducing the range she will eliminate many of the disadvantages of the present long ranges required for the Whitehead torpedo. Again, a well disciplined crew is given a chance to do something, for their quarters will be infinitely more comfortable than those they at present occupy in the torpedo boat; they will have a feeling of safety which they do not now enjoy, and they will know that they will land their torpedo close enough to blow up the ship. Such a craft may be compared with a large automobile torpedo, one of such a size to carry a crew, and yet possessing not only similar automatic devices for controlling its position, but having them supplemented by direct mechanical contrivances under the direct control of the brain of man. Such a boat will be practically irresistible and invulnerable; will even resist the attack of heavy ordnance, and is a type that it will be impossible for a battleship to avoid.

While giving importance to the designs that will utilize the semi-submerged principles, the great need of the hour for harbor and coast defense is a small torpedo boat that can be submerged, having within it a storage battery of sufficient power to give it a submerged range of a few hours, with 9 or 10 knots surface speed, and from 6 to 8 knots submerged.

PROGRESS IN SUBMARINE BOAT CONSTRUCTION.

It will perhaps be said that very little has been accomplished in submarine navigation in proportion to the number of years during which the system has been under consideration and experiment, but it must be remembered that the best commercially accepted torpedo—the Whitehead—has struggled through many years, is yet very far from being perfect, and directive power for it has only recently been secured by the introduction of the principle which was the controlling one of the Howell—that is, the gyroscope. One must also recall that most torpedo destruction has been done with a bag of explosive on the end of a pole, and that the submarine boat will permit us to get closer to the enemy, with a bigger bag of explosive, and with less danger to the pole.

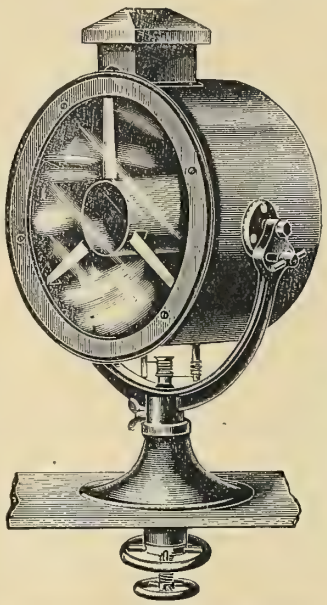
If one compares directly the chance of the ordinary torpedo boat with that of a submerged boat for landing a torpedo, there certainly can be but very little doubt as to which is the more hazardous.

If there are no other elements of value in the submarine boat than its influence upon a modification of the present type of torpedo boat, this alone should certainly give it prominence and weight—a powerful influence which certainly cannot be ignored.

The annual meeting of the American Society of Naval Engineers will be held in Washington, D. C., commencing Tuesday, January 10, 1899. Several prominent engineers have given assurance that they will prepare and read papers.

IMPROVED APPARATUS.

Acetylene Light.

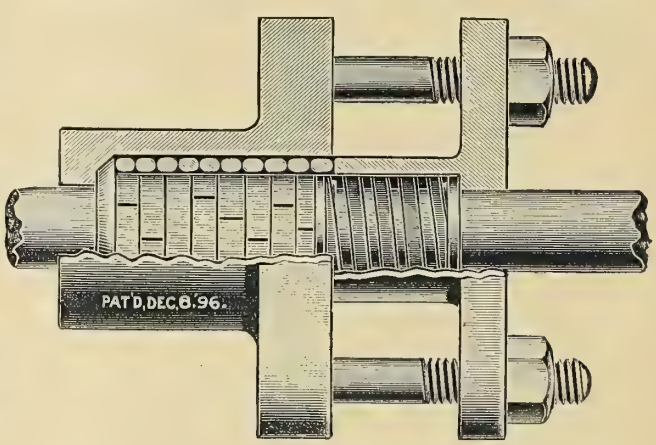


ACETYLENE SEARCH LIGHT.

Our illustration shows a new pilothouse light designed to burn acetylene gas. It is in fact a small search light with a power of 2,000 candles, which the manufacturers guarantee, with the use of a 1-2 ft. burner, 25 candle power. Any object within a radius of 600 yards upon which the beam is projected can be readily seen, and under the most favorable circumstances objects 1,000 ft. distant are rendered visible. The makers are J. B. Colt Co., 7 West 29th street, New York.

Rigby Metallic Packing.

The packing here illustrated consists of a series of split rings made of a suitable composition, which are closely fitted to the rod and held in position by a coiled spring bearing on the gland head. The stuffing box outside of these metal rings is packed in the usual way with special flexible packing, which is compressed by the gland ring. Thus it will be seen that as the gland nuts are screwed down, the flexible packing is expanded laterally and brings the metal rings to close snugly about the rod. The manufacturers,



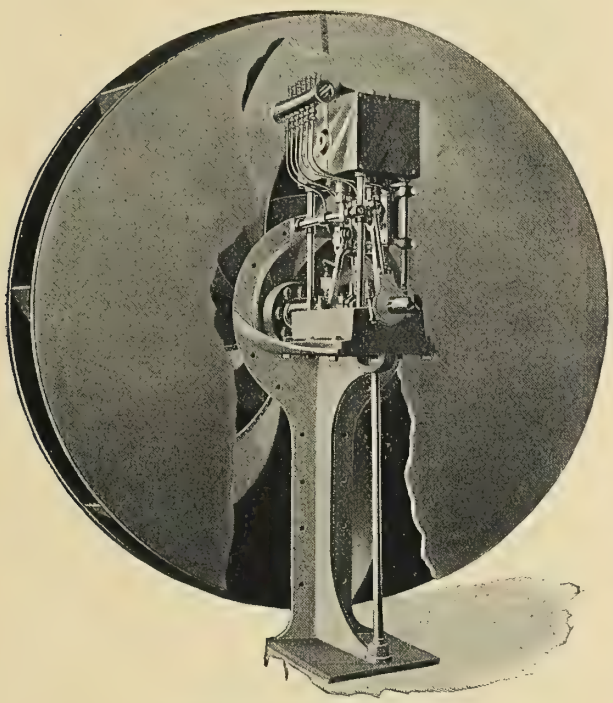
RIGBY METALLIC PACKING.

The Henry S. Mould Co., Carnegie Building, Pittsburg, Pa., claim for this packing minimum friction, simplicity of construction, ease of operation and great durability. Unlike many other

makes of metallic packing, it is not dependent upon the steam pressure for its compression, by which design the friction at the stuffing boxes increases proportionately with the load.

Engine Connected to Blower.

The engine shown in the illustration direct connected to a blower is a compound built by W. D. Forbes & Co., Hoboken, N. J. The cylinder dimensions are: High pressure, 2 1-2 in.; low pressure, 4 in., and stroke, 4 inch. It is designed to run at 800 revolutions. The cranks are set at 180 deg. apart. All forgings are of high grade machinery steel without welds. Provision is made for taking up all possible wear, and a very satisfactory system of oiling by means of a drip feed is fitted to the engine. The apparatus here illustrated has been in constant use

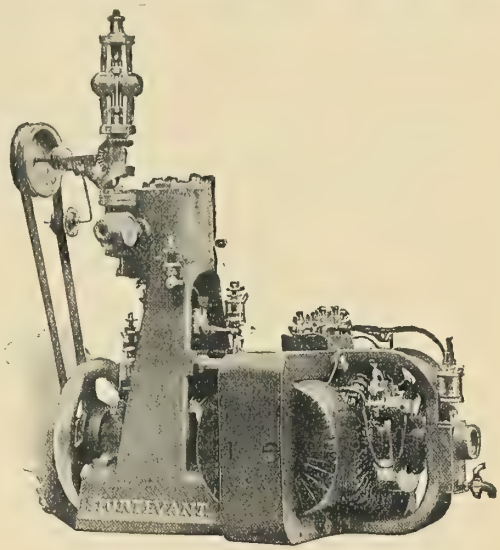


FORBES ENGINE AND BLOWER

for the past eight months with exceedingly satisfactory results. This type of engine is also adapted for marine propulsion, being fitted with reversing gear when required for small launches. The firm, in fact, makes a specialty of high grade compact engines.

Small Sturtevant Lighting Set.

The lighting outfit here shown was designed for torpedo boat service, and several of these sets have already been furnished to the United States Navy. The engine, which has a cylinder 2 in. by 2 in., is compact, extremely stiff and carefully designed as regards adjustment of wearing parts and the character and proportions of the material employed. Steam is admitted through a special form of throttling governor, which is capable of controlling the speed of the engine within very close limits. All moving parts are provided with continuous sight feed oilers. The engine was designed with a large factor of safety to operate under 200 lbs. pressure at 1,000 revolutions and indicate 3 H. P., although intended to be operated at a somewhat less output. The specified limit of weight of the entire set was 500 lbs., the rated capacity of the engine to be 1.5 K. W. In point of fact, the finished machine weighed only 400 lbs., thus coming 100 lbs. inside the specified limit, bringing the weight efficiency down to 0.266 lbs. per watt at rated capacity. The center of gravity of the set was kept as low as possible in order to economize head room and to insure steadiness in running. This low center demanded a special design, which was met by the adoption of a four-pole field, with only two field coils on the consequent-pole type of magnetic circuit. The field magnet itself is of wrought iron, the pole pieces of the same material being bolted to it. Thorough ventilation and a large radiating surface are secured by making the armature of large diameter. By means of air-ducts placed at the center and ends of the armature core, the armature is to a certain extent transformed into a centrifugal blower and thorough ventilation is secured. As the back end of the spider is completely closed and thereby rendered oil proof, the air is necessarily drawn through the commutator. Only two brush holders are used as the armature is of the two circuit, four-pole, barrel-wound type without cross connections. These brush holders are of the reaction type. The generator is compound wound for a constant E. M. F. (at constant speed) under all changes of load, from no load to 50 per cent overload without sparking. Twenty-five per cent overload can be carried with safety. This Midget set, so called, was designed and constructed by the B. F. Sturtevant Co., Boston, Mass.



STURTEVANT SET FOR TORPEDO BOAT.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building, New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.

S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representative.

L. L. CLINE, Detroit, Mich., 47 Hodges Building.

Traveling Representatives.

E. L. BLANCHARD. J. E. WHITTLESEY.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

IN this issue we present a complete report of the proceedings at the Sixth General Meeting of the Society of Naval Architects and Marine Engineers held in New York. The meeting was well attended and carried through with a good deal of professional enthusiasm. As shown by the Treasurer's report the financial condition of the Society is excellent. Applications for membership were very numerous, and by vote of the Society more than fifty candidates were admitted in the several classes of membership. This is a good indication of the increasing interest which is being taken in the higher development of the shipbuilders' art by those engaged in this branch of scientific effort. Doing things because some one did them a generation or more ago is fast getting to be, if it is not already, an unprofitable reason in the drawing room or the yard, and this is true also of acts of omission. Not that any method is necessarily bad or good, because it is old or new: in the past, indeed, it was the genius of American designers that built ships to capture records and have a determining influence on the designs of to-day. The work of the Stevenses, the Ericssons, and the Webbs of yesterday is an incentive to the naval architect and engineer of to-day. But the process of trial and error is not as necessary as is was, for the laws which apply to the construction and propulsion of vessels are better understood and those who study them are better able to take advantage of the certain results than those who have already fixed their horizon of science. To make easy and effective the carrying out in practice of those principles already understood and to develop along scientific lines the points which practice suggests are the chief purposes of such a Society. Its progress and professional prosperity is the index of the condition of the shipbuilders' art in America. There was offered for discussion at the meeting a variety of papers along advanced lines, some of which were suggested by recent naval experiences, and these were supplemented by several excellent topical questions. Owing to the fact that many naval vessels which had seen active service had recently been put out of commission, and their officers widely scattered, the fullest discussion of these matters was not possible. Even in their absence, however, the discussion of such subjects was extensive, and it is likely that the extraordinary interest in matters affecting naval practice, which the war has occasioned, caused a more extensive consideration of naval affairs than usual. And in this also may be found the reason why comparatively little attention was given to subjects relating to engineering pure and simple; a fact which occasioned some comment. A very pleasant feature of the meeting was the excursion to the plant of the Bethlehem Iron Co., at South Bethlehem, Pa., where a most interesting programme had been arranged; all the operations of steel production being shown in succession. This was so successful that it might well become a precedent for similar social occasions in the future.

NOTHING that occurred at the meeting of Naval Architects and Marine Engineers was more timely than the resolution introduced by Lewis Nixon, which will be found in full on another page. There could be no more important subject to engage the attention of the members than adequate provision in construction and equipment of vessels for the saving of life at sea. Mr. Nixon deplored the "lack of appliances" now existing and summed up the situation by saying: "Since the earliest time, so far as I know, there have been practically no advances made in the method of saving life at sea; certainly nothing commensurate with what has been done in other directions." This, of course, is the view from the standpoint of construction, and it is in-

deed to such a Society that shipowner and traveling public alike must look for practical improvements. Meanwhile it is not at all necessary for owners to await action by this or other similar Society to take measures to protect life in the operating department of marine work. Not only is lack of appliances responsible for repeatedly recurring losses of life, and the most responsible too, but lack of preparation is just as apparent. In passenger vessels, those with which we are most concerned here, there are two distinct classes to be considered: seafaring men and landsmen, or passengers and crew. This introduces a complication which does not exist in cargo boats or war vessels. In the liner, therefore, there are three components of this problem, viz., proper appliances, skilled persons to operate them, and unskilled and helpless persons to be saved. Concerning the first the hint given by Mr. Nixon that possibly some portion of the superstructure would be the "ark of refuge" in time of disaster merits immediate practical consideration and study. The ship's boat to-day is a semaphore of helplessness rather than a signal of security. On this and the other subject of properly trained crews to man such contrivances a whole chapter might be written. But here we will allow that the best boats and detaching gear are carried, and that the crew are properly familiar with handling them; but what about the passengers? The invariable attitude of a steamship company towards its passengers is to ignore mishaps, and, should by any chance the question come up, give unlimited and general assurances that accidents are highly improbable, not worth considering, and that the company's ships have a special dispensation from Providence providing for all possible emergencies. Then the statistical mariner talks glibly about the infrequency of loss of life at sea as compared with railroad travel. This is beside the question and all such explanations are mere subterfuges. What matters it to the passenger if no ship had ever gone down before, should it come to pass that the vessel he is on founders in mid-ocean with all on board? Everyone is not a fatalist, though there is an old saying that "if you are born to be hanged you'll not be drowned." From constantly deceiving others the steamship owner comes to deceive himself, until some horrible disaster shocks the world and cuts down profits. There is danger in going down to the sea in ships, lots of it, and of a kind peculiarly impressive to the landsman could he but realize it. It is really childish if not cowardly to ignore it. There is no necessity of going to the other extreme of making the passenger feel that he is participating in the preliminaries to his own funeral when he goes aboard for a voyage. But now, from the time he buys his ticket until he debarks at his destination, the passenger is kept in complete ignorance of possible mishap and preparation for getting away in safety. When a mishap occurs he is panic stricken, not knowing where to turn or what to do, and filled only with a mad desire to go upon deck and worry the already anxious officers with unanswerable questions. In the modern liner with its series of decks and compartments dimly lighted, or in case of mishap possibly not at all, the passenger easily becomes confused, then frantic and when he reaches the deck, if ever, has usually lost control of himself. Though life belts are now provided in every cabin it is not an exaggeration to say that not one landsman in four would know how to fit one on. Passengers, on going aboard a vessel, as soon as possible, should be made acquainted with the location of their cabins relative to the exits to the deck, also how to put on the life belts provided, and also what to do in time of disaster. They should be assigned to stations, to the portions of the deck or boats which they are to occupy, and among the cabin passengers at any rate on long voyages an occasional drill would be an advantage. All passageways and staircases should be plainly labeled, so that the directions on deck and below could be read at a glance. In fact no precaution, however simple, and the simpler the better, should be slighted in providing for the general safety. All the men in the saloon of any big liner are not cowards or incompetents; many would be proud of the opportunity of doing something for the general good, and the aid of even a score of resolute men who had some idea of what they ought to do would be of immense help to the ship's officers in time of disaster. Objection would be raised, of course, that such measures would scare off intending passengers, but it would be better to lose a few that way than lose a whole shipload at sea. In a very brief time passengers would fall in with the reasonable regulations of any company, and in the end the business of a company enforcing such rules would be very materially increased. Managers of theaters are compelled by law to take many such precautions for the safety of their audiences in case of panic or fire.

PROCEEDINGS AT THE 6TH GENERAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS HELD IN NEW YORK.

WHEN President Clement A. Griscom called the members of the Society of Naval Architects and Marine Engineers to order at the opening session of the sixth annual meeting, there was hardly a vacant chair in the auditorium at engineering headquarters, 12 West Thirty-first street, New York. In fact the meeting which extended throughout Thursday and Friday, November 10 and 11, was about as representative a gathering of the marine interests of the country, merchant and naval, as could be got together. So unpropitious was the weather that had the Society been occupied with other than sea interests it is probable the roll of absentees would have been large. But rain in sheets, and wind half a gale, did not even dampen the enthusiasm of the crowd that piled mackintoshes and umbrellas in the cloak room and then gathered in the hall and welcomed the President with a hearty round of applause, while the rain pattered an echo on the skylight overhead.

First on the list of business which preceded the technical features of the meeting, came the report of the Council. This included the annual statement of Secretary-Treasurer Francis T. Bowles, which showed a total membership of 541, made up of: Life members, 6; life associates, 3; active members, 319; associates, 195, and juniors, 18. During the year four members had died and four members and five associates had resigned.

The deceased Members were: Rear Admiral Daniel Ammen, John F. Pankhurst, Charles E. Emery and John H. Dialogue.

Those who resigned as Members were: John E. Jeffries, Arthur Beardsley, John T. Henthorn and Leo Morgan, and as Associates, John R. Bartlett, Thomas J. Allan, Theodore W. Cramp, Albrecht Hesse and Samuel Seabury.

The financial report showed a very sound condition, the balance in bank having been substantially increased. The exact figures were: Balance on hand, November 9, 1897, $2,595.14; receipts during year, $4.728.97, and expenditures, $3,682.48 leaving a balance on hand on November 9, 1898, of $3,641.63.

Secretary-Treasurer Francis T. Bowles now read the list of candidates whom the Council had recommended for election, which included:

Members:—George F. Coleman, with Moran Bros. Co., Seattle, Wash.; Albert Charles Diericx, chief draughtsman American Steel Barge Co., West Superior, Wis.; Albert C. Engard, chief engineer, U. S. N., Philadelphia, Pa.; W. D. Forbes, W. D. Forbes & Co., Hoboken, N. J.; Daniel Edward Ford, assistant general manager American Steel Barge Co., West Superior, Wis.; William E. Keough, consulting engineer, East Boston, Mass.; James J. Killilea, superintendent of construction United States light-house establishment, East Boston, Mass.; John Leonard, passed assistant engineer, U. S. N., Navy Yard, Brooklyn, N. Y.; George Muller, leading draughtsman hull department, Wm. Cramp & Sons, Philadelphia, Pa.; Richard Lane Newman, general manager Globe Iron Works, Cleveland, Ohio; John Platt, Thorpe, Platt & Co., New York; John D. Torrey, draughtsman, bureau construction and repair, navy department, Washington, D. C.; Josiah Wedgewood, manager of drawing offices, Sir W. G. Armstrong, Whitworth & Co., Elswick Ship Yard, Newcastle-on-Tyne, England; Clarence W. Wiley, superintendent engineer, Boston Tow Boat Co., East Boston, Mass.; Frank Willis Grogan, N. A., coast and geodetic survey, Crescent Ship Yard, Elizabeth, N. J.; William Strother Smith, passed assistant engineer, U. S. N., Wm. R. Trigg Co., Richmond, Va.; John Lawrence Frisbie, in charge of construction and repair, Lockwood Manufacturing Co., Everett, Mass.; William J. Wood, N. A., Goodrich Transportation Co., Chicago, Ill.; J. Harvard Biles, University of Glasgow, Scotland; Jarvis Bonesteel Edson, New York.

From Associate to Member:—Henry E. Rottmer, draughtsman bureau construction and repair, navy department, Washington, D. C.; Henry G. Smith, assistant naval constructor, U. S. N., Navy Yard, Brooklyn, N. Y.; William Henry Deming, mechanical engineer and draughtsman, Continental Iron Works, Brooklyn, N. Y.; Albert Lloyd Hopkins, inspector Newport News Company, Newport News, Va.; Axel Gustaf Rossell, chief draughtsman, Wm. Cramp & Sons, Philadelphia.

From Junior to Member:—Sydney L. Wood, draughtsman, superintending constructor's office, U. S. N., Newport News, Va.

Associate:—Walter Aucker, superintendent of floating equipment, B. & O. R. R., Camden Station, Baltimore, Md.; George Crouse Cook, ship draughtsman, Wm. Cramp & Sons, Philadelphia, Pa.; Edwin S. Denise, marine department, Deane Steam Pump Co., New York; William E. Fitzgerald, president Milwaukee Dry Dock Co., Milwaukee, Wis.; Everett G. Haymaker, assistant draughtsman, U. S. N., Bath Iron Works, Bath, Me.; F. D. Herrimann, surveyor general for the Great Lakes Register, Chicago, Ill.; James W. Kellogg, manager marine sales, General Electric Co., Schenectady, N. Y.; John A. Lord, assistant draughtsman, U. S. N., Bath Iron Works, Bath, Me.; Theodore Lucas, calculating draughtsman, Cramps' ship yard, Philadelphia, Pa.; Julius Martin, master electrician, equipment department, navy yard, Brooklyn, N. Y.; Alfred G. Smith, secretary and treasurer, New York & Cuba Mail Steamship Co., New York; Frederick C. Starke, vice-president, Milwaukee Dry Dock Co., Milwaukee, Wis.; Arthur P. Allen, marine engine draughtsman, Newport News, Va.; Frederick S. Brinton, draughtsman, Crescent Ship Yard, Elizabeth, N. J.; Wilson Brown, superintendent, Amboy division, P. R. R. Co., Camden, N. J.; Wallace Downey, Townsend & Downey, Brooklyn, N. Y.; Frederick D. Owen, draughtsman, bureau construction and repair, navy department, Washington, D. C.; George H. Wilson, draughtsman, superintending constructor's office, Columbian Iron Works, Baltimore, Md.

Juniors:—Edwin S. Alexander, ship draughtsman, Newport News Company, Newport News, Va.; William Binley, assistant draughtsman, U. S. N., Newport News, Va.; Almon F. Bowen, draughtsman, Newport News Company, Newport News, Va.; Dean Clark, engine draughtsman, Newport News, Va.; Ernest I. Cornbrooks, draughtsman, Harlan & Hollingsworth Company, Wilmington, Del.; Thomas M. Cornbrooks, draughtsman, Harlan & Hollingsworth Company, Wilmington, Del.; A. A. Packard, draughtsman, Herreshoff Manufacturing Company, Bristol, R. I.; Benjamin C. Fernald, assistant ship draughtsman, U. S. N., Newport News, Va.; M. Hobart McGann, draughtsman, Newport News Company, Newport

News, Va.; Albert L. Swasey, draughtsman, Newport News Company, Newport News, Va.; Edward J. Tuck, assistant foreman, Bath Iron Works, Bath, Me.; Benj. C. Tuthill, copyist draughtsman, U. S. N., Philadelphia, Pa.; William Willis, engine draughtsman, Newport News, Va.; Fred A. Hunnewell, assistant draughtsman, naval constructor's office, Newport News, Va.; H. L. Meeker, Jr., draughtsman, navy yard, New York; Arthur Willey Chase, assistant draughtsman, U. S. N., Newport News, Va.; Charles P. Paulding, draughtsman, W. D. Forbes Company, Hoboken, N. J.

These were voted on *en masse* and unanimously elected.

Here President Griscom yielded the chair to Doctor C. H. Haswell, and the Secretary, by direction of the Council, placed the existing list of officers in nomination with the addition of George W. Dickie, of the Union Iron Works, San Francisco, in place of John F. Pankhurst, deceased. There were no other nominations submitted, and the recommendation of the Council was carried without dissent.

PRESIDENTIAL ADDRESS.

President Griscom having again taken his place in the chair, read his address. In opening he referred to the splendid record of the United States Naval vessels during the past year—vessels which were the product of domestic shipyards. The demand for auxiliary vessels, however, exceeded the available supply of the American merchant marine; the vessels purchased or taken numbering, for both navy and army, about 200 in all, and ranging from yacht to transatlantic liner, had been fitted out for war uses with incredible despatch. Auxiliary vessels rendered valuable service and gave sea experience to a large number of men, which, he hoped, would prove a stimulant to sea employment. Here President Griscom referred to his statement made in 1894, that a modern naval force "could not be produced on the spur of the moment." It was necessary to have an adequate force in peace time, not only for the consequent preparedness, but as a training school for the development of men of the Hull, Decatur, and Farragut type. The full development of a naval force, however, was not possible unless the growth of the merchant marine kept pace. In time of war, too, those nations which had encouraged shipbuilding and shipowning in time of peace, would have a sufficient and well-trained merchant marine to draw upon for material. Since those words were spoken the country had been at war and had found that in order to sustain effectual naval and military operations, not only was it necessary to draw upon the domestic merchant marine, but to supplement this by the purchase of a score of foreign vessels; an act which would have been impossible had not the flag of a friendly nation floated over those vessels. It was not too hopeful, he believed, to predict that one result of the war, the acquisition of distant insular territory, would be an increased activity in shipbuilding, and possibly the turning point from which the nation would regain its onetime rank as a shipbuilding, shipowning, and seafaring people. It was a very happy testimony to the skill of the membership that orders had been placed here by foreign nations for war vessels. Structural material, too, made here, had been shipped to Europe on its merits as to quality and cost. The commercial products of domestic yards during the past year had not supplied all waste, and in addition to this demand there were good prospects of orders for ships for foreign trade. The people were more than ever awake to the value of an efficient navy and had endorsed the present extensive naval shipbuilding programme. In conclusion the President referred to the "gratifying and pleasing field of future activity for the members, involving the solution of many interesting and difficult matters of administration and business, as well as questions of technical importance which would tax their highest ingenuity and skill."

First Technical Session.

President Griscom then announced that the first paper on the programme would be read preliminary to the topical discussion on the same subject, and meanwhile the members would hear the paper entitled:

"THE STANDARD NAVY BOATS."

By Arthur B. Cassidy, Esq., Member.

By way of preface, the author refers to the New England dory, the New Bedford whaleboat, the Ranger boat for naval survey use in Central America, the racing cutter or barge, and the light steam or naptha launch in common use on the coasts, as examples of highly successful craft for special uses. Navy boats have also been designed for their special purpose. Requirements include: Strength to stand hard usage in rough water; stability under sail or oars; great carrying capacity, and weight as light as is consistent with necessary strength. Steam cutters must not only carry their own loads, but be capable of towing other heavily loaded boats. Aboard war vessels stowage space is limited, and the number of boats which can be carried also limited, so that the boats provided may be on occasions very heavily loaded with men, equipments and provisions—as in abandoning ship. Landing parties mean heavy loads, a probable pull through surf, and much banging upon the shore. In 1870 navy boats were classified according to size, but not form, and Chief Constructor Philip Hichborn has completed the standardization. In carrying out this scheme the best existing boats were selected and studied, also opinions invited from navigating officers who held different opinions about the rig. About 75 per cent favored the sliding gunter, and the others preferred the standing lug. The list of boats classified includes: Steam cutters, launches, cutters, barges, whaleboats, gig whaleboats and dinghies. Essential qualities of design for naval boats are: Safety, weight, comfort, and speed, in order. The author comments on each requirement, and gives much practical information concerning materials and methods of construction. In the matter of speed for steam cutters only a moderate rate is sought. In rough waters this ranges from eight knots for 40 ft. cutters to six knots for 28 ft. cutters. There are about a thousand boats in use in the Navy, and the average life is ten years.

DISCUSSION.

Harry De B. Parsons asked what experience had been had with the folding boat in the U. S. Navy. This type was used extensively in foreign navies, and to some extent in the merchant marine.

W. P. Stephens, speaking from the point of view of the yachtsman, said the rigs of the boats seemed small, and it seemed as though the sail area might be somewhat increased to advantage, for the boats were used under sail. In yachting, in work similar to that performed by navy boats, cruising, the yawl rig had been found to be very efficient, with the main sail in the middle of the boat, a small mizzen mast, a short bowsprit and a jib. Sail could be reduced or shipped very readily. The yawl used in yachting could go under jib and mainsail effectively, or even under mainsail, while the navy boats seemed more or less schooner or sloop rigged. Yachtsmen, to get a large area of sail than small size of rig would allow, often adopted the Chinese plan of using several battens to extend the sail and thus get a larger area than would be given by the straight line from clew to peak.

Captain Jacob W. Miller inquired whether any thought had been given to the use of centerboards in navy boats, so as to increase their sailing power to windward. In his experience with such boats as used by the Naval Militia, he found they were magnificent boats in a seaway and in every other respect,

but it was impossible to work well to windward with them.

Colonel Edwin A. Stevens wanted to know whether the use of metal for small boats had been considered, also whether cypress plank had been used instead of white cedar.

Lieutenant W. P. White, U.S.N., called attention to the report of the board of naval boats, which appeared in No. 70 of the Proceedings of the Naval Institute. As to rig, he objected to the sliding gunter rig and cited the case of a boat very fast in pulling races, but slow under sail—sliding gunter rig—when working to windward; going before the wind she more than held her own. He quoted Captain Barker, U.S.N., as an authority who opposed the sliding gunter rig and advocated the lug rig.

W. P. Stephens said a very wide range of experience had been had in canoes and small yachts with sail of all kinds, and the difficulties met with were largely those which attend navy boats. "We want sail that will stow, and that will spread in an area and be generally effective," he said. "We began in canoeing with the low standing lug which Lieutenant White speaks of, but discarded that long ago; also the sliding gunter. A small sail which has found favor is a variation of the sliding gunter, where, instead of the top or gunter being fixed in two irons (as I believe it is in navy boats) to slide, it is fitted so that it can be detached from the mast. At the foot there is a jaw which goes against the mast and slides vertically, and at the top a sling—it can be dropped almost instantly. The boom can be easily detached and the entire rig stowed separate from the mast—a great advantage in stepping the mast. Mr. Herreshoff has introduced a sort of sprit rig, which is a very simple affair and hoists with a single halyard, and as soon as the halyard is started the sail falls instantly. The old sliding gunter seems to be out of date." He then referred to small boats for yachts, to which very little attention had been given. The average yacht boat lacked displacement, had considerable rise of floor and of sheer, with a low waist, so that in the trough of the sea she rolled badly. There was room for much improvement in this direction.

Naval Constructor John G. Tawresey, U.S.N., replying in the absence of the author, said that though the Navy boats had been standardized, the work had not stopped, for, though the dimensions and form were fixed, the boats were being gradually improved. Navy boats were subject to very rough usage. Boats on board ship were usually carried close to the smoke-pipes, where there was great heat—the boats were built of wood. Hoisting took more out of the life of a boat than any other one thing. If scantlings were proportioned so that boats would not be strained in hoisting the boats would be enormously heavy. The blast of guns often seriously damaged boats. That Navy boats are held in high esteem by Navy men was shown by the orders sent in from the various auxiliary craft during the war for standard Navy boats. In response to the questions asked, he stated: Folding boats had been experimented upon in the Navy and reported on unfavorably. As to metal various metals had been tried and aluminum investigated. Some years ago iron and steel were used for steam launches and found to be unsatisfactory. The wooden boat was considered all around the best, but it should be recollected that the Navy boat was not put in the water in the spring and taken out in the fall, but was continually in and out of the water, and the bottom was always accessible. In former times the outside of boats was coppered, but this was abandoned as unnecessary. As to the centerboard, this was simply a question of weight. A boat could be built strong with a centerboard, but that would increase the hoisting strains. The Navy boat was not built as a sailing boat, but for all around use, and the constructors recognized that they could be built much better for sailing exclusively. He replied to the criticisms about rig by making a comparison with the case of a commanding officer of one of the single-screw U. S. corvettes, who complained officially that the boat did not sail as well as the famous ship Constellation. The present rig suited three men out of four, and it was not likely that a rig could be found which would satisfy the fourth man.

The Chair called upon Captain W. C. Wise, U.S.N., for an expression, and this officer briefly replied, expressing his preference for the French lug, which his experience had shown to be the best for safety, convenience, and period of lowering the sail and making sail, and also for carrying capacity.

BILGE KEELS AND ROLLING EXPERIMENTS—U. S. S. OREGON.

By Asst. Naval Constructor Lawrence Spear, U. S. N., Member.

This paper is of an extremely technical character, narrating the results of experiments made with U. S. S. Oregon—before and after fitting her with bilge keels—and then recounting the generally accepted assumptions and theories pertinent to the case, which have for their object the evolution of such formulæ as would be of practical value to the designer. The original designs for the battleships Oregon, Indiana, and Massachusetts called for bilge keels; but during the construction of these ships it was decided to omit keels, to facilitate docking. Sea experience, however, "demonstrated the desirability of some steadying influence." The actual maximum inclination of the Oregon "probably" never exceeded twenty-two degrees—the deck edge goes under at eighteen and a half degrees. This angle was reached while the ship was at anchor in Drake's Bay, subject to a long low swell, with a period approximating closely to that of the ship. The vessel was immediately gotten under way. The angle of heel was inferred from clinometer observations, which, says the author, are notoriously inaccurate. Subsequently the vessel was docked and bilge keels fitted. The "Oregon's" keels are 34 in. deep near the edges, tapering to 14 in. amidships. The vessel was rolled both previous and subsequent to docking under substantially the same conditions of stability and trim. Without keels the mean period for a single swing was 7.6 seconds, and with keels 7.83 seconds—an increase of a trifle over three per cent. Trials were held in slack water, no current, vessel moved to buoy, wind negligible. The "extinctive effect" of the bilge keels plainly stated is: U. S. S. Oregon, starting at an inclination of six degrees to the vertical, required, without keels, sixty swings to reduce to an inclination of two degrees, while with keels the corresponding extinction required only ten swings. Under way the effect of bilge keels would be greater. In discussing results the author states the belief that the extinctive work done by bilge keels comes under three main heads: (1) Increased wave-making resistance; (2) Disturbance of natural stream line motions about the ship; (3) Direct resistance of plane surfaces of keels. Though there is yet no data upon which to base a quantitative division of the total resistance between these three heads, the third can be easily shown to be a comparatively small factor. The author makes a comparison between the Oregon experiments and those conducted by the British Admiralty with H. M. S. Revenge.

In the absence of the author, W. F. Durand read this paper.

DISCUSSION.

Naval Constructor John G. Tawresey, U.S.N., in opening the discussion, said: "In the early part of this paper the author speaks of the practice of omitting the bilge keels from the larger battleships. I would like to say in relation to that practice that the

arguments advanced to justify the practice did not by any means receive the approval of professional men generally. At the time this question came up the question of the resistance to the rolling of the ship had been pretty thoroughly investigated. Resistance had been parceled out under three heads, the skin friction, the direct head resistance due to deadwoods and projections of that kind, and wave-making resistance, and it had been fully established that the wave-making resistance constituted by far the larger part of the resistance to rolling. In addition to that there had been experiments demonstrating the effectiveness of bilge keels. They had been tested and tried; and in the face of all that it is rather remarkable that any one should take an equation representing the effect of the bilge keel and ascribing the entire effect to the head resistance, the movement of the bilge keels sidewise through the water, and arguing from that action deduce that the relative effect of a bilge keel on a large ship like a battleship was comparatively small. If the entire effect of the bilge keel had been due to the head resistance, as assumed, that position would have been entirely correct, and the keels would have been relatively ineffective on these large ships. But it is well known that one of the principal methods used to generate waves in oil tanks and other places for experimental purposes is by oscillating a plane surface normal to itself, and it is rather remarkable that that should be overlooked. I think we have got to seek the true reason for the omission of these bilge keels, not only in our own service, but abroad, in the question of docking." Mr. Tawresey then referred to the author's printed paper, took exception to a statement which attributed the extinctive work done by bilge keels in part to the "disturbances of natural stream line motions about the ship." In the speaker's opinion, a very small part of the resistance came under that head. He referred to Mr. Froude's experiments on the Greyhound, which showed that after allowing for the skin friction, due to the increased surface of the ship when the bilge keels were added, the resistance to the motion of the ship through the water was not greatly increased by the bilge keels. If the stream lines had been radically disturbed by the addition of bilge keels the effect would have been observed in the increased resistance to the propulsion of the ship.

Naval Constructor Francis T. Bowles, U.S.N., referred to missionary work he had done several years ago on the subject of bilge keels. The result was they were fitted to nearly all the larger vessels and did their work very satisfactorily. "When it came to the building of battleships," he continued, "we had got so accustomed to bilge keels that it seemed as if we might leave them off, especially as they interfered with going into dry dock. Now, as a matter of fact, the very first experience of those ships at sea showed that they were not safe without bilge keels. I venture to state that no one will ever again attempt to build a battleship without a bilge keel, no matter if it is necessary to build a new dry dock."

Assistant Naval Constructor R. M. Watt, U.S.N., said the actual time consumed at the Brooklyn Navy Yard in fitting bilge keels to the Massachusetts, under the direction of Mr. Bowles, was sixteen and a half working days.

PORTABLE PNEUMATIC RIVETERS IN SHIPBUILDING.

By W. I. Babcock, Esq., Member.

This paper embodies the experiences of the Chicago Shipbuilding Co. during three years of constant experimenting with machine riveting. As a result the company is now able to drive every rivet in a ship by power machines, operated by unskilled labor, and in the last ship built about 250,000 rivets were so driven out of a total of 340,000 rivets. At the outset a stationary steam riveter had been used driving 1,800 rivets in ten hours, at a cost of not over half a cent apiece, a saving of 2 1-4 cents each over the scale for hand work. For portable machines compressed air was decided upon in preference to hydraulic power on account of severe winter frosts, and because the air could also be used for caulking and chipping hammers, drills and reamers. After describing the various types of tools employed, and the rigs needed to keep them up to their work, the author states that the quality of the work done with these tools is admitted by all inspectors to be first-class in every respect, and "far better and tighter work" than those driven by hand. As to cost, adding air, repairs, etc., the saving is from one to two cents per rivet over piecework, prices for hand work depending upon the location in the ship and averaging 1 1-4 cents. In the ordinary lake steamer of 4,000 tons the saving is from $4,000 to $5,000 over hand work.

DISCUSSION.

R. L. Newman, of the Globe Iron Works, began the discussion by stating that during a like period his company had been making similar experiments with equal success. On the revenue cutters Algonquin and Onondaga the bulkheads were riveted up by pneumatic hand tools to the entire satisfaction of the Revenue inspectors. At the outset he had tried riveting the shell with a pneumatic riveter, and after driving the rivet, endeavored to mill it off. Many rivets so treated were not tight, and it was found necessary to set down again with a hammer—three operations in all. The result was that the saving was not more than 25 per cent over hand work. He believed that in the future for countersunk shell riveting a frame would not be used, but the work done with a heavy hand tool, using the ordinary holder on, and finishing with the pneumatic chipper, and finally the hammer.

John Platt, referring to Mr. Babcock's reference to hydraulic riveters, said he had experience in this direction. "It seems strange," he said, "to one who has had connection with English yards for the past fifteen years and has known the kind of machinery in use there, to find people commencing again to take up riveting with a hammer, and simply using the blow instead of the steady pressure, that has been considered so very necessary by all inspectors and shipbuilders abroad. As a matter of fact, in the larger work it would be utterly impossible to do what has been done here. If Mr. Babcock had to deal with 1 1-8 in. and 1 1-4 in. and larger rivets, it would not be possible to fill the holes properly. About shell plating, I might refer to the work done in the last year at Harland & Wolff's Works, at Belfast. We there erected for them an immense gantry, which spans the whole shop. The crane is of the general construction of the one in use at the Union Iron Works, and this travels up and down the whole length of the shop. The riveters are carried on special cranes, which travel to themselves up and down the runway. These machines have about 6 ft. or 7 ft. gap, with 40 to 50 tons on the rivet. This apparatus is designed for the building of the Oceanic, where it was absolutely necessary to go into power riveting. In England or Ireland they would take up hydraulic riveting because that is one thing that they have had very much experience with, and they are satisfied with it. The question of cost does enter into it, but not to a very great extent. There are hydraulic riveting plants working in Canada and the north of Russia, and they use a certain amount of crude glycerine in the water and have no trouble at all. It has been said that the big riveting plant at Harland & Wolff's is not an economical one, but within the last three months they have ordered a duplicate plant, after working the other a considerable time, so they must be satisfied with it. On the smaller work it does seem to me that very good work can be

done in the way suggested here. It would be interesting if Mr. Babcock would tell us the largest rivets he has driven and what experience he has had in trying the driving of rivets of increased size."

Naval Constructor John G. Tawresey, U.S.N., said in his experience of several years with pneumatic tools in ship work he had found that they worked economically, rapidly and thoroughly. "There is one drawback," he remarked, "in connection with the working of pneumatic hammers and riveters generally, and that is the infernal racket that they make and the general demoralization of the nerves of every one in the neighborhood. I have no doubt that that increases somewhat the cost of the work around it." He inquired of the previous speaker as to the proportions of glycerine and water used in cold climates.

Mr. Platt replied: "One-third glycerine and two-thirds water. They use common crude glycerine."

L. R. Pomeroy suggested the question, "What are the limitations to the use of pneumatic riveters?" A large number of locomotive builders had gone extensively into the practice of riveting up boilers with pneumatic tools and had abandoned it, because they could not make tight joints. Such tools were only used now on foundation rings or tank work. The explanation given was that the air was too elastic, whereas with hydraulic power a constant steady pressure was secured, and there was not the same difficulty of leakage as a result.

Mr. Babcock, replying to the queries, said, one inch was the largest size of rivet driven by pneumatic hammers in his yard. In bridge shops and in building gasometers larger tools were used and inch and a quarter rivets driven. There was no reason why a 2-in. rivet could not be driven with a sufficiently powerful hammer. The pressure of air at the tool itself was of the greatest importance. This should not be less than 100 pounds. With a new compressor building at the Chicago yard he hoped to get 125 pounds, and expected to be well repaid for the additional outlay necessary. The reason pneumatic hammers were liked better than hydraulic compression riveters was because they could be handled so much more easily—by hand, in fact. The gantry crane at Harland & Wolff's was an extremely expensive construction and practically its only use was to handle the heavy riveters. The same work could be done here with pneumatic riveters, any one of which could be carried about by two men. Noise was an objection, but not so bad that it would cause riveting to be stopped. As to the limitations on the use of these tools there was none, provided suitably designed apparatus was used. As to the question of cost, he believed that the Chicago yard was the only one having a machine for shell riveting. In the last ship built there, 51,306 shell rivets were driven by hand, piece work, at an average cost of 3.99 cents apiece. With the pneumatic shell riveter 74,493 rivets were driven at an average cost of 2.96 cents per rivet. This figure represented the direct cost—not including the cost of air, repairs, etc. The shell riveter was developed in the shop during the building of this ship. After the keel of the ship had been laid and the first machine put to work every hand riveter in the shop went out on strike, and stayed out eleven weeks. Then the company built twelve more machines and put new men to operate them. In future work he hoped to reduce the cost per rivet. He did not believe it possible to drive shell rivets by a heavy hammer held in the hand. The whole matter, however, was in an experimental stage, the shell riveter having been developed within a year.

Second Technical Session.

Vice-President Edwin A. Stevens called the members to order at 2.25 o'clock, at the opening of the afternoon session. He announced that Captain W. H. Jaques would exhibit stereopticon views of submarine boats, with a brief descriptive talk. The powerful electric lantern was then brought into use and views of various boats, both in the water and out, were thrown on the screen. These included the Spanish boat Peral, the Nordenfeldt boat, and both the U. S. boats Holland and Plunger. He referred briefly to the various trials made with these boats, at home and abroad, and spoke with enthusiasm of the future of the submarine boat. A vote of thanks concluded this interesting feature and the members gave attention to the reading of the paper on:

TORPEDO-BOAT DESTROYERS.

FOR SEA SERVICE.

WITH SPECIAL REFERENCE TO THE CONDITIONS THAT PREVAIL ON THE PACIFIC COAST.

By G. W. Dickie, Esq., Member.

In opening the author refers to the materials for opinions and possible changes of practice that the recent naval operations have provided. In the torpedo-boat destroyer sea-going and sea-keeping qualities should be of first importance, and also high speed and battery power. The present destroyer is up to requirements in the matter of speed, but only for a short time in smooth waters, and speed has been made paramount to all other qualities. Conditions peculiar to Pacific coast service include, long distances between harbors and rough water along the coast line. The author believes the 420-ton destroyers are a "decided improvement," but not up to Pacific coast requirements. Annexation of Hawaiian Islands requires greater radius of action for such vessels. He suggests a type of vessel 250 ft. long, 800 tons load displacement, with trial speed of 25 knots and radius of action at 12 knots of 3,200 knots. The design gives good berthing space and quarters, capacity for 200 tons of coal, an armament of six 6-pounder guns and two 4-in. rapid firers, and considerable protection by 1 in. nickel steel. Under water torpedo tubes only are recommended. Such a boat should be capable of full speed on a spurt, and be perfectly seaworthy, and available as a despatch boat or scout as well as a fighter.

DISCUSSION.

John Platt, in opening, said: "I take it that we can discuss the boats, with respect to sea service on any coast, without limiting it to the Pacific coast, and I shall speak of it in this connection. I take exception to the way in which Mr. Dickie has treated this subject. I fully agree with his ideas with regard to the boat which he describes, but I think that he is classifying it in the wrong class and that he has not treated it just fairly and right. The boat that he has described, I think, would be better classed as a torpedo cruiser or torpedo gunboat—not as a destroyer. I think I am right in saying that in 1890 the Department in Washington designed a boat, which they called a torpedo-cruiser, and which was about the size, or maybe a little larger, and about the same speed, but which unfortunately was never built. From what Mr. Dickie says here, and from what has been reported to us from the war, it is very certain that such boats should be built. Mr. Dickie describes an ideal torpedo-boat destroyer, and one of the things he says are necessary is the highest speed possible, so that they can overtake a torpedo boat. There are very many torpedo boats that are over 25 knots, and the limit of speed of his boat to start with is 25 knots. Of course, there is good reason for that. Then he says that it cannot be said that the present type of torpedo-boat destroyer comes near these requirements andthat quite a number of destroyers now meet the requirements in matter of speed if required for a short time, in smooth water only. I made runs last year in one of the standard British destroyers—a 30-knot boat. It is a standard 300-ton British destroyer. The first day we went out to make the runs there

was quite a heavy sea on; in fact, so heavy a sea that it was not possible to complete the contractor's trial. But they ran the three hours' run, so that they could get some results from it. The wind was blowing enough, and there was enough of a sea on to knock down the speed when we were running against the wind to about 27 knots, and when we were running with it, up to 32 knots, and the boat maintained this for three hours, making that variation, depending on which way she was running. The same boat I went on quite a number of times, and in moderate weather there was no difficulty in maintaining the speed of 30 knots for three hours, and we did it continually. Then Mr. Dickie says: 'The quality of speed has been made paramount to all other qualities to such an extent that the full speed can only be reached when the conditions are such that the sea-going qualities can be neglected.' That is hardly true of the present class of British destroyers, because they do run at their full speed for three hours, which is not a short run, and do that repeatedly time and again. To illustrate it, we were out on the Mallard, off the Nore. The torpedo-destroyer Fame was at Sheerness. She was then being put in commission, and she was given a commissioning trial, and she went out of the harbor while we were there. She had a deckload of coal, and she was in charge of the Navy entirely, and she ran out, and they ran her for an hour, and when they came back the captain reported that they had made 29 1-2 knots under those conditions. So that in the British practice certainly, in one or two classes of boats, other qualities besides speed have been given the very greatest consideration. Speaking of speed, there they have to obtain that speed on a given coal consumption. The maximum coal consumption is 2 1-2 pounds per horse power, and when they are burning from 60 to 80 pounds of coal per square foot of grate that is something they have to build a good boat to be able to do. As a matter of fact, in the recent trials, in quite a number of them, the consumption has varied in Thornycroft boats between 2.02 pounds per horse power and 2.15 on all these trials of three hours duration. He speaks of the 420-ton destroyers lately ordered by the Government as being a decided improvement over the others. On the lines on which he is considering the matter, they undoubtedly are. But it is a question whether as pure torpedo-boat destroyers they are any improvement at all. Torpedo boats, as he says, operate from harbors and inland waters. Torpedo-boat destroyers, of course, have to travel with the fleet. But when they are traveling with the fleet they have not to make any such speed as 30 knots or anything like it, and they travel with the fleet at the ordinary speed and are able to keep up that speed, and then when necessary they can make their bursts of speed, and have a faster speed than the torpedo boats. Take a boat of the 300-ton class. Such a boat is 210 ft. to 215 ft. long, and some of these other boats run to 230 ft. or 240 ft., with an extra two feet of beam; and providing they run on an even keel, which they are designed to do, they are still good sea-going boats, and as destroyers are perfectly useful and good. The larger boat which he describes here is practically such a boat as H.M.S. Speedy, which was one of the first torpedo gunboats built on the other side. It is not nearly so fast as these two, because at the time that was designed there was not nearly as much experience in making and building these boats. But she made 22 1-2 knots. I speak of that here because Mr. Dickie speaks of the expert management, with special trial trip crews and all such things needed to make speed under such conditions. She developed 4,700 H. P. on her trial. In actual service conditions, since that date and to-day, she develops 5,000 H. P. whenever required, and can do that easily.

Stevenson Taylor: "I would like to ask Mr. Platt how the speed of the Fame was determined. You refer to the Fame having made, under extraordinary conditions as to loading, etc., a speed of 29 1-2 knots. That is to say, the captain reported that she made that. As a rule, the speed reported by the captain is very much in excess of the actual speed of the boat, so I should like to ask him how that speed in particular was determined."

Mr. Platt replied: "In the English service all speed on trials are determined by six runs over the measured mile, that forming part of the three hours' run. They run between points, and on those three hours they are able to standardize the screws and find out just how many revolutions give a certain speed. Those boats are fitted with proper arrangements of counters for the total revolutions and all such things, and those remain there. In the run on the Fame they took the revolutions from the counters and with the data obtained, not from just one run or two runs, but several runs in the different stages of the trials, they were able to determine very nearly what the speed was, and I think the actual speed, too."

FIRST TOPICAL DISCUSSION.

The Chairman now announced that the first topical discussion, "The Utility of Torpedo Boats, and Has the Submarine Boat a Place?" would be taken up in connection with Mr. Dickie's paper.

Secretary Francis T. Bowles explained that the Navy Department had recently put out of commission all the torpedo boats and consequently the officers who had served in these boats were now widely scattered and unable to attend the meeting. He then read written communications from officers on the subject, which were chiefly criticisms of present conditions. Among the defects in our system pointed out were the multiplicity of types of boat and lack of homogenity, the lack of specially trained crews and inadequate facilities for taking care of boats in peace times. These papers follow:

TORPEDO-BOAT UTILITY.

BY LT. COM. W. W. KIMBALL, U.S.N.

After the experience of the China-Japan war, in which torpedo-boats played the most important and effective roles, after the experience of the Spanish-American war, in which torpedo-craft caused more apprehension and more radical departures from accepted methods of naval warfare than all other craft employed; after these late experiences there can be, in an assemblage of people interested in naval architecture, no question as to the utility of torpedo-boats, considered as a general proposition. In all foreign navies worthy of the name, the tactical place of the torpedo-boat is well defined and the great usefulness of her enormous power within her limited field of work, is as well understood as are the characteristics of any other type of fighting craft; and yet we, the people of the United States, and we, the people of the United States navy, the majority of us, at least, do seriously question the utility of the type.

The reason for our unique attitude in this matter of torpedo-boats is readily understood when we contemplate the determining conditions in our country, all of which are more or less familiar to the members of this society, but a few of which I would venture to recall to your remembrance: First, we have never approximated to any policy in torpedo-craft design or building program, as is apparent from a glance at the displacement column in the navy register; second, we have the vaguest notions as to design and requirements of torpedo-boat machinery as is shown by a comparison of the displacements and horse powers of our boats; third, we are at least fifteen years behind the civilized world in our ideas as to the conservation of the material of our boats, as is shown by our laying them up and hauling them out of water, a process that has long since been given up by people who have tried it, because they have found that nothing causes more

rapid deterioration; fourth, we have only a small, very small, personnel competent to handle torpedo-boats, and this small trained personnel we do not at present propose to increase, or even to utilize as a nucleus for the organization of the crews of the new boats that must soon be received from the builders and put in commission; fifth, we have only very few officers of the engineer corps competent to give experienced trained engineering supervision to those repairs on torpedo-boats, which are attempted at navy yards, and those few are rarely available for the duty; sixth, we have never attempted a real torpedo-boat attack drill, and consequently have no experiences to aid us in deciding upon the tactical value of the craft. This list of a half-dozen well known determining conditions of our torpedo-boat service could readily be increased three times by the enumeration of other equally important factors in the case; but it would be idle to do so since the list as it is, gives ample reason for questioning the utility of torpedo-boats in the United States.

I will venture the opinion that, in time, some of these conditions will be modified; it seems to me that they must be for the following reasons: First, if we are to ever have use for a navy of fighting ships we must have an efficient torpedo-boat service to supplement the fixed coast defenses, or our fighting ships will surely be deflected from their legitimate off-shore work to the in-shore defense of our ports and coasts; second, from the extent and condition of our attackable coast, and from the fact that torpedo-boats are the only craft (bar armor-clads) that can check raiding armor-clads, we should lead the world instead of lagging behind it, in the development of torpedo-boat efficiency. When these facts become sufficiently familiar we may begin to utilize the heterogenous lot of boats now built and building, and may then become impressed with the necessity of systematizing designs and types.

As we will never possess enough torpedo-boats to cover our extensive coast properly, we should strive to develop that design which will best allow our boats to concentrate at and work from any base temporary or permanent, between Eastport, Me. and Galveston, Texas. Such a design combining sufficient torpedo armament for use against ships, sufficient gun armament to give the boat a fighting chance against a hostile destroyer at night, sufficient speed, endurance and sea-going qualities, can readily be worked out upon a displacement of 120 to 150 tons, providing we bear in mind the facts that we must, for lack of shore bases, furnish depot ships, or floating bases for the support of the boats, and providing always, that we obtain a clear idea of what we intend the boats to do, and then try to learn how they should best be used for the intended purpose. The true base boat, the 100 footer that we have tentatively attempted to develop, is too much of a luxury for us to consider until a real torpedo-boat service has been established. The line of demarkation should be sharply drawn between the torpedo-boat intended primarily for the defence of ports and coasts against ships, and the destroyer primarily intended for the defence of ships against torpedo-boats—between the boats of 120 to 150 tons and the destroyer of 400 to 500 tons.

It has been borne in upon us in the navy that the only way to do good gun-work is to get the best guns and then learn how to shoot them; but we are apparently utterly unaware of the more important fact that the only way to do good torpedo-boat work is to get the best boats for our purpose and then learn how to use them. If the navy axiom "the only way to learn how to shoot guns is to shoot guns" be true, how much more then by the course of sufficient reasoning is it true that, the only way to learn how to use torpedo-boats is to use torpedo-boats, since the shooting of guns is so much simpler a matter to learn than is the proper utilization of torpedo-boats. If in the future we shall learn to utilize proper torpedo-boats properly, we will then know, as people in foreign services now know, that the feat of the Dupont in making 12,000 miles of deep sea work during the late war and turning up with her machinery in good condition after it, was, in an engineering sense, more remarkable than the Oregon's run around the continent and reaching Key West with her machinery in good condition. We question the utility of torpedo-boats because we do not know how to utilize them.

TORPEDO AND SUBMARINE BOATS.

BY LT. A. P. NIBLACK, U.S.N.

The torpedo boat has not many friends in the United States, either in or out of the navy, and this, too, in spite of the recent improvements in torpedoes, by which their efficiency has been increased at least 100 per cent. The Obry attachment has made possible an absolutely safe and accurate underwater discharge, as well as a deadly accurate discharge. We have no torpedo boat history. Other countries have gradually developed a system. We have jumped into the middle of it. We are beginning at the top, and our policy is very unstable and wobbly, because nobody really knows very much about them. Many very estimable people think they go under water.

During the war this summer it was found necessary to use the torpedo boat on dispatch and blockading duty. No one can deny that most of them did their duty well, considering that they were not designed originally for that purpose. We are not willing to accept the lessons taught us in Europe, where everything is worked out thoroughly, and where all we have to do is to read and learn. We must have our own costly experience, and we are calmly proceeding to make every mistake possible, and in four or five years we will be where some navies are now, but with our methods we will always be behind. The outlook is not encouraging. We have almost no trained officers or men. Some pressing necessity has driven the Department to putting our boats out of commission. This means not only a loss in training, but a deterioration in material, because the method of laying up is open to the objection that it is contrary to accepted methods abroad. Even if it is successful there is no need to experiment.

In Norway, Sweden, Denmark and Austria, boats are hauled out of the water under sheds in the winter season. In the northern countries it is on account of the ice, but more especially because there are no crews available, as conscription is only for six months in other than the winter season.

In Austria all the boats are at Pola, and in winter are hauled out under sheds only because of the heavy gales and because money is not available to construct a basin in which to moor them. The Austrian officers disapprove of hauling boats out. The say it causes a loss of speed to the boat of from one-half to one knot each time it is done, and injures the hull and machinery. Of course, we may be able to haul our boats out without injury, but the cold will hurt them.

In Germany the boats stay in the water always, except when periodically docked or under repairs. In winter steam heat is kept on them constantly, the steam heating pipes being connected with a boiler on shore, or else to an old torpedo boat or hulk used only for this purpose. They regard a torpedo boat as a delicate instrument, and yet they go to the extreme of sacrificing speed to strength. Their boats are all single screw, but they have a bow rudder in addition to the after one, which makes them handle as well as a twin screw boat. The bow rudder may be raised or lowered at will. Even with our twin screw boats such a rudder would be most acceptable.

Boats in commission in Germany are available for war in the time it takes to coal and provision and get a few explosive fittings carried only in war (for

countermining, etc.). Boats in the first reserve have their men and all stores aboard, except war heads and explosives. The crews live on board station ships adjacent, and boats of the first reserve are ready for war in six hours. Boats in the second reserve have their stores in an immediately adjacent storehouse. Each boat has its own separate building. They can be ready for use in forty-eight hours, or in time it takes to call in the crew from civil life. All fittings of boats are absolutely standardized, and in the group built at the same time the parts are interchangeable. Their store system is ideal. We could never approximate to it in a hundred years, and we are getting away from standardization as rapidly as the different private firms can drag the Navy Department into permitting it. Our steps are all rapidly backwards.

Our store system is so onerous that in putting the Winslow out of commission some days ago, and having unusual assistance in trying to make a record, it took seven days to lay her up. I have no idea that in April, when the boats are to re-commission, they will really be ready for sea inside of a certain number of weeks, and with all the care given to the engines in the way of red and black lead, tallow and vaseline, I doubt if they can be put in running order short of several weeks. Meanwhile, in the case of war, where are we? Of course, there is no danger of war. There never is until it comes.

It has been my personal good fortune to see practically every torpedo boat in four or five foreign navies and to study the various types somewhat superficially. I unhesitatingly give it as my opinion that the Dupont, Porter and Morris, built by Herreshoff, are the three best boats of their type in the world, and that there are very few poorer ones than the Foote, Gwin, Rodgers, Winslow, and Ericsson. Herreshoff is as much a master in boat building in general as Edison is in the field of electricity. The engines of the Dupont are as distinctly superior to those of the boats above mentioned as a Blake pump is to a handy billy. I don't say this in criticism. It is only grief that Herreshoff does not build all our boats, or that we do not copy his models and fittings.

Germany is where she is because Schichau has built all. The standardization is perfect. We have an assortment of boats coming on now running the gamut in displacement, horse power and type, till one is forced to the conclusion that there is no recognized relation between horse power and displacement, nor anything but a belief that any 1 H. P. shop building establishment can build a modern torpedo boat, or any engineer or constructor design engines and hulls. Personally the outlook is to me very gloomy, and probably it is just as well that I am to temporarily sever my connection with the torpedo boat service during this, the teething period, when all of us are learning things.

If we consider the mechanism of a Whitehead or Schwartzkopff torpedo, we will find that all the remarkable things which it does may also be done by a submarine boat. In the torpedo the opening and closing of valves, the regulation of depth, the steering, the various safety devices and the length of the run are all automatic. In a submarine boat these corresponding things are regulated by hand. There is no real reason why the submarine boat should not be as successful as the automobile torpedo. Its speed is not and need not be so great, but there is no problem connected with it which has not been solved.

We have in the Holland boat a combination of the elements of success. Along its lines we are sure to get the best results. As more experience is had the submarine boat will take its place as a disturbing element in the plans and operations of war. The Holland boat is a distinct success, and I hope will be purchased by our government. There is one difference between a submarine boat and a torpedo, which is very important. In the torpedo all gearing is oiled automatically, and a torpedo may lie idle six months or more, with no deterioration. With the submarine boat the care of all the rather delicate apparatus or mechanism must be unremitting and tireless—much more so than in a torpedo boat, which is difficult enough. There is another feature of submarine boats in general, which has to be considered. If a propeller fouls a buoy rope or chain or mooring when the boat is under, it is "all up" with the crew, because there is no way of getting out to clear it. I understand that in the boat building at Baltimore the government requirements were so difficult that it was necessary to give her five propellers—five vulnerable points, and five chances for trouble. No one can blame the designer for this, but the propeller question is easily solved by having as few as possible and having those guarded. I made a trip in the Holland boat, and everything worked perfectly. The sensation of diving is a little unusual—otherwise it is rather tame sport compared with a torpedo boat at high speeds. There is no reason to consider the submarine boat as dangerous. It can be made almost absolutely safe. Indeed, in war it has many more chances than a torpedo boat, but its crowning virtue is that it makes blockading almost impossible, and strategically in war has a place all to itself.

TORPEDO BOATS IN ACTION.

BY LT. WILLIAM L. RODGERS, U.S.N.

In the recent war the Spaniards were unenterprising, and the Americans had no opportunity, so torpedo boats did not use their torpedoes, and the public seems to have jumped somewhat hastily to a conclusion that the war has discredited these crafts. One might as well think that armored cruisers are discredited because the Spanish ones accomplished nothing. In order to show how erroneous are the opinions now popularly current in regard to torpedo craft, the nature of the torpedo must first be understood as well as the limitations which its characteristics impose on the employment of the boat; then the boat itself may be considered.

Before going further I would like to call to mind a fact which naval architects too frequently overlook in discussing naval design. This is that mechanical and architectural improvements are valueless unless they confer desirable, tactical or strategic advantages in due proportion. This observation applies with particular force to the question of speed, of which the importance seems to be overestimated on many occasions. Perhaps this is because of all nautical and tactical qualities, speed alone can be measured absolutely. Thus in the consideration of rival designs it appears with singular advantages over other features, whose tactical importance is not less, although less easily demonstrated. But to return to the torpedo. Briefly, the torpedo is an automobile submarine boat, weighing 850 pounds, and carrying a cargo of explosives. It is launched by a very small powder charge, and in launching it takes a deep initial dive, after which the depth regulating gear brings it to the desired depth. Until recently it has been without inherent directive force, and its course, after discharge, was influenced by the speed of the boat firing it, as well as by the chance of the wave surface as it enters the water. Its maximum speed has been 30 knots, and its range at that speed about 400 to 500 yards.

Now note how all these peculiarities affect the tactical employment of the torpedo boat. First, although the boat runs at a depth of from 5 to 15 feet, the torpedo dives deeper than that when leaving the boat, and there is risk in hitting the bottom in less than 30 feet, the risk increasing with diminishing depth. Thus the torpedo cannot be fired when the boat is in shoal water. Then rough seas make its course erratic,

although a new device, soon to be issued to our service, diminishes this source of error. Finally the speed of the torpedo is not superior in any great ratio to that of ships, so that the man firing must make allowance for the speed of the target at the instant of discharge. An error of only two or three knots in his guess will cause a considerable displacement of the torpedo on the target. At 500 yards range an error of three knots in his guessing the speed of the enemy will cause the torpedo to miss a 300-foot ship. Thus the boat must be within 400 yards before she can begin to fire with any reasonable expectation of success. At the same time the commanding officers will feel disposed to fire the instant the enemy opens, on the ground that a chance shot at long range is so much, and if one waits for closer range the torpedo may never be fired at all.

Taking up the subject of the boat itself, we have great engine power in a small displacement, and consequently machinery so light and frail that after every hard run it is necessary to lie by for a little while and tune up again. Moreover, the quarters for the men are small, and hot in summer, and cold in winter, making life impossible for long periods of active work. Those who maintain that men can become accustomed to the service lack experience. It is simply impossible for a crew numbering only twenty men to maintain itself on blockade duty for long periods in a topedo boat without gradual deterioration of health, and a large sick list following any unusual exertion. A minimum crew of thirty-five to forty is needed for continuous service. Further it must be recollected that owing to their small size torpedo boats cannot maintain their nominal speed except in the smoothest seas. A gale which would cause a great Atlantic liner to slow down one or two knots would make the Dupont slow from 20 to 25 knots below her trial speed.

The field for torpedo boats is clearly indicated by these considerations. Properly the boat is almost as purely a weapon for coast and harbor defense as a gun mounted on shore. Although it is possible to use it for distant service, it should be kept in port, ready to rush out upon an attacking enemy when circumstances are favorable. But the fate of the Spanish boats at Santiago and San Juan show that a day attack is almost hopeless. The torpedo boat should therefore be small enough to depend largely upon invisibility at night. As for speed, it should not be excessive, but we should seek rather somewhat greater solidity in the machinery, especially in the auxiliaries, together with boilers giving steam somewhat excessve for the engines. All machinery, I think, should be in duplicate, including boilers, engines, all auxiliaries, and also the main steam piping. All auxiliaries should be independent of the main engines. Twin screws are desirable for the sake of reduced draught and precision of manoeuvering, although the single engine has certain good points. As for speed, it seems to me that 22 to 23 knots, or that of the fastest cruisers, is ample. Any greater speed can so seldom be used on the open sea, that it is not worth the necessary sacrifice. Upon this point it must be recollected that in delivering an attack by night or in thick weather, a speed of 10 or 12 knots only would be used. Greater speed might cause a marked bow wave, and occasional flame from the smoke-pipes, or noise from the blowers; all these are objectionable. Full speed will probably not be used until the retreat, and then it is not very important, except personally to the people on the boat. This at least was the consensus of opinion among the commanding officers of our boats during the late war.

I think the Morris and Cushing may be taken as the type of the best class of torpedo boat, although the former, I am told, rolls excessively. They have sufficient speed, and are seagoing boats for use from a local base. Smaller boats such as the Talbot have not sufficiently great seagoing qualities, and only single engines and boilers, so that they are of little utility; still, in quiet summer nights they might do service. I cannot doubt for an instant that the field for torpedo boats in the way of local defense is a most important one. It is unfortunate that the lack of positive results this summer has led the general public to believe that they have been overrated, but I feel sure that this is not the idea of the navy. On the contrary, it is scarcely an exaggeration to say that the Spanish destroyers were as much dreaded as the big ships. Only the singular apathy of the Spaniards prevented them from making good use of their fine boats. In fact, the torpedo boat stands just where it did before the war began. It is a weapon with great possibilities, but its capabilites are not yet definitely known. Therefore, its moral powers will be very great until we have a fuller record in regard to it, and for this reason it must not be neglected at present. On the contrary, the element of doubt about it adds very much to its effectiveness, if it is known that the enemy intends to use it boldly.

The torpedo boat destroyer is the tactical reply to the torpedo boat. She is exactly the same type, but larger, faster, and with a good battery of light guns in addition to her torpedoes. She must be able to accompany the fleet and remain at sea with it when it blockades, in order to keep off the hostile torpedo boats. Invisibility is no longer a desideratum and she must be sufficiently high forward to be a good sea boat, and to afford fairly comfortable quarters for a large crew. The engine room force should be large enough to stand in three watches, and the fire-room force should be in three, with an extra watch to take day's duty in overhauling boilers not in use, running distillers, and for other extra work. The deck force necessary for manning the guns will be more than enough for the three watches at sea.

Speed should be greater than that of torpedo boats, but not excessively so, as the larger boat has an advantage in rough weather in proportion to her size. Thirty knots is ample speed for a destroyer, and personally I should prefer a somewhat less speed, say 28 knots, with somewhat heavier machinery and large boilers, and the duplication of parts, including main steam piping. The duty of such boats will be to act as despatch boats and scouts. When on blockade they will take the inner line, allowing the heavy vessels to lie well out every night. When two hostile fleets meet, it is probable that a general fleet action will be preceded by a combat of destroyers, just as on shore the cavalry forces feel each other and engage before the main bodies.

There should be no boats whose size is between that of Morris and the large destroyers. Money spent in such vessels is not well invested, no matter how fine they may be in design and workmanship. The reason is that the medium size boats such as the Foote and Porter, are not quite big enough to keep company with the fleet, while they are larger and therefore more expensive than is necessary to act from a local base. As the utility of torpedo boats is under discussion it may be interesting to point out why the late war threw so little light on the question.

The principal Spanish naval forces were concentrated at Havana, Santiago and San Juan, and included torpedo boats or destroyers at each place. Our forces naturally were concentrated in front of the Spaniards. At each place the opportunity of the Spanish boats was ideal, and their failure to accomplish anything is owing entirely to the singular lack of initiative, which was the universal Spanish characteristic both ashore and afloat.

As for our boats there was nothing for them to attack except at Santiago and Havana, at both of which places floating obstructions rendered it impossible to rush through the entrances, while their narrowness, and the presence of machine guns and

infantry, rendered it hopeless to attempt to remove the obstructions, and then proceed on. In these circumstances it seemed that torpedo boats might do useful service in blockading and despatch service, and they were so employed. That they were not well suited for such service is evident, but, nevertheless, they were of more or less use, and in default of proper work for them it was wise to make them do what they could, no matter at what cost to themselves.

DISCUSSION CONTINUED.

R. L. Newman said he had heard a very similar discussion in respect to British torpedo boat destroyers ten or twelve years ago. The first boats were not at all successful and there was much kicking, but the Admiralty apparently persisted in their efforts and had now developed a fine class of vessel. As to the strength of such boats, he recalled the statements of Mr. Yarrow, the English builder, made at the 1897 meeting of the Society, as to the voyages made by his boat from England to South America. The season was not selected, and yet the boats made good time and arrived in fine condition. Mr. Yarrow on that occasion had expressed surprise at the low price at which boats were taken by American builders, and he reasoned: "How could high class results be expected?" The speaker believed that when the difficulties in construction of such boats were properly realized by builders they would turn out some of the finest boats in the world, if they had not done so already.

Mr. Roberts wanted to know if anyone had any information about the disastrous boiler explosion on a torpedo boat in Puget Sound recently. Several men were killed and the tubes pulled out. This was only a newspaper report.

Colonel E. A. Stevens, from the chair, said in his experience lately with a hydraulic test he had seen a tube pull out of the lower drum of a boiler.

F. L. DuBosque said he was informed that the explosion on the U. S. S. Davis was caused by low water.

John Platt said the accident was reported as having been caused by low water. The tubes blew out but particulars had not been given out. Overheating would not cause the tubes to come out of the upper drum. This was shown very clearly from the boilers of various boats at present at the Navy Yard. He named the Porter, the Dupont, the Foote, and the McKee, and said that almost all these boats were burned out in Cuban waters. There had been no disastrous results. That sort of thing was not unusual through carelessness, and in fast running it had occurred all over the world. Never before had there been a case of any disastrous explosion because a tube had never come out of a drum after a boat had been passed and accepted.

Secretary Francis T. Bowles now read a communication on submarine boats by Lieutenant-Commander W. W. Kimball, U.S.N.

Chief Engineer John Lowe, U.S.N., in discussion, said that with the present efficient type of boat the chief question to be considered was: "Is submarine navigation useful to us?" He then referred to the use to which a submarine boat could have been put at Santiago in making a reconnoissance when Admiral Cervera's ships were in the harbor. With ordinary vessels it would have been impossible to force the entrance to the harbor without great loss of life and property, with the possibility of the moral effect that a defeat might have. He foresaw the use of submarine boats of various classes, such as observation boats, despatch boats and gunboats.

W. P. Stephens, referring to the type of vessel proposed by Mr. Dickie, said it would be a very handy little gunboat, a boat more than equal to the Gloucester and her class, and as compared with the larger of the yachts, the Mayflower, the boat would probably cost half as much and be more useful.

Stevenson Taylor, from the chair, invited experiences along the lines of the topical discussion.

Assistant Naval Constructor Richard M. Watt, U. S.N., said in the absence of officers of the Dupont and Cushing it was fair to state that those boats reached the Navy Yard with the boilers in good condition. When the torpedo fleet reached the Yard extensive repairs were necessary on most of the boats, though on several there was comparatively little to be done. These latter included the Morris, Dupont, Gwin, Talbot and Cushing. Mr. Watt said he had had charge of the repairs to the torpedo fleet, under the direction of Naval Constructor Bowles, and after many hours spent on each of the boats he was of the opinion that the Morris was the ideal type of torpedo boat proper—a boat operating from a base. "I would have no torpedo boats except those of the Morris type," he said, "and from those I would advance at one step to a 400-ton or 500-ton torpedo-boat destroyer or torpedo cruiser, or torpedo gunboat, that possesses the qualities named in Mr. Dickie's paper—seagoing and with speed and a battery superior to torpedo boats; able to serve as a scout and as a despatch boat."

Charles D. Mosher: "Referring to the remarks of Lieut. Niblack, I do not think the time for standardizing torpedo boat fittings has arrived; as ever since the beginning of the torpedo boat it has undergone continual changes, the main feature of which has been to increase the power on a given displacement, with a corresponding increase of speed. This has been realized by improved material, by advantage of the knowledge gained from past experience, by constantly greater demand for higher speed, and I believe we are to-day very far from the final speed results. Compare the speeds of some of the more recent boats, Mr. Parson's Turbinia for instance, and the contract speed of other boats he now has in hand, with the speeds that have been realized by the present boats of this Government. The speeds of these foreign boats are so much above ours that our boats would certainly be next to useless if both were to meet on equal grounds. Until the maximum speed is arrived at I think it is not practicable to attempt to standardize the fittings of torpedo boats—they have constantly been undergoing improvement. To build slower boats than our enemy has, would undoubtedly place us in a very unequal, and I may say even hazardous position, because if overmatched in numbers it is certainly desirable to be able to run as well as fight. I believe there will eventually be a very broad line between the size of the torpedo boats proper and the sea-going destroyers. Undoubtedly the harbor boats will be limited to something like 100 tons, with a speed of perhaps 35 to 40 knots; while the destroyers should undoubtedly have an equal speed with a displacement of upwards of 400 tons, and be adapted for sea going work. I believe the future destroyer will be a vessel having a raised superstructure, from which the fighting can be done, with a deck turtled over to near the water line, and equipped with conning towers, which together with the deck would be protected by 1 in. armor, so that they would be proof against the smaller guns, and in fact against any guns carried by torpedo boats. The saving of weight of the top sides of the present designs of destroyers will admit of the extra weight of the armored turtle deck, and the modified design will have greater stability due to its lower center of gravity, and at the same time present a much smaller target. From such a design a very satisfactory gun platform and a good sea boat can be developed, with very powerful fighting capacity. The conning towers, stacks and cowls would be protected by nickel steel above the superstructure, and there would be sufficient room between the superstructure and the turtle deck to admit of the free passage of any waves likely to be encountered, without destroying the upper deck. As regards the personnel, I believe no one is justified

in condemning the torpedo boat on account of the incompetency of ordinary engineers, who without training cannot be expeted to properly handle the machinery of these boats, any more than he would be justified in condemning modern high powered guns from their performance in inexperienced hands, a marked example of which was forcibly illustrated by the Spaniards at Santiago; not that they did not have good guns, but their inability or incompetency to handle them, is where the difficulty lay. I believe there are plenty of men in the Navy, who with a little training and periodical practice will be able to sucessfully handle torpedo boat machinery, and I do not believe that the torpedo boat should be condemned any more than the chronometer should, because it requires intelligent and careful treatment without this essential the modern gun or the chronometer is certainly useless. The torpedo boat is undoubtedly recognized as a very important factor in modern warfare, and if the Navy Department should insist upon it, it could undoubtedly school the personnel to give complete satisfaction."

Naval Constructor John G. Tawresey, U.S.N., prefaced his remarks by the statement that he was an avowed unbeliever in torpedoes and torpedo boats. He believed, however, that the boat described by Mr. Dickie would be a very useful type for a variety of purposes. As to torpedoes, if he were in command of a battleship he would like to have the launching tubes on deck, with a canvas cover over them, to show to folks—for the moral effect. He would like to know if that was what torpedo boats were for, or were they intended to actually destroy vessels. He did not think past experiences justified much hope for that. A vessel properly armed and on the alert would make a successful attack an improbability. Little was to be learned from the late war in which we had not fired a torpedo. The stream line motion, set up around a vessel of any reasonable speed made the best kind of a net that could be desired. If a torpedo did strike the destruction of the vessel would not necessarily follow, as experiments had shown.

John C. Kafer said it was generally agreed that the torpedo boat was built for the purpose of destroyng ships. They had maximum power with minimum weight and they could be run at maximum speed for only an hour. Mr. Dickie's boat, however, was built to keep the sea, strong enough to withstand ordinary rough usage, and yet have the machinery in good condition ready for maximum speed at all times. As to torpedoes he did not favor the automobile type. It would be much better to build the torpedo right on the end of the boat and run up to the ship to be destroyed, taking all the chances. The ordinary torpedo boat was too light to stand an ordinary sea without being shaken up considerably, and the boats now building, with flat sterns, would pound themselves to pieces in a seaway. It would not be possible to choose the time when the torpedo would go into action and so the weather might not be "such as we would like to have it." Consequently the torpedo boat should be built strongly having this in mind. Torpedo boats should not be put to uses other than those for which they were built, except in emergencies. No commanding officer should have the right to use a torpedo boat as a despatch boat. The speaker referred to the showing which the Spanish destroyers made at Santiago—thirty-knot boats running at eighteen knots.

John Platt: "I hope Mr. Kafer does not blame the Spanish boats for their speed. The protected cruisers did not do much better."

F. L. Du Bosque was of opinion that all that had been said only emphasized what Lieutenant Niblack maintained that boats should be standardized, especially where there was not available trained personnel. Torpedo boats should be so alike that a man could go from one to another and understand what the various functions of the boat were. As an illustration he referred to water-tube boilers. "Water-tube boilers are a success," he said, "phenomenally so on a great many torpedo boats, and there is no reason why they should be made a failure on any one. I believe the failure of water-tube boilers on any boat is due to neglect, when the boilers are properly designed. We have had personal experience with four different types of water-tube boilers, three of which were of excellent design. On all four, what little trouble has been experienced has been clearly traceable to managment. After some little experience I can say safely that all four of these types are now being operated successfully by the most unskilled labor in the fire room. Further than that, they are being operated from sixteen to eighteen hours every day of the week and week of the year. I do not think a torpedo boat is called upon to do such work at any time. The use of the water-tube boiler there is spasmodic and that is where the evil lies. Between the intervals of use a different force of men is employed in running the boat. If the boilers could be standardized so that the force of one boat could go to another and understand that the method of firing used on one could be applied to the other, and that the feed arrangements were identical, the boiler room force would not have the slightest difficulty in operating torpedo boats."

These expressions seemed to find much favor with the members present, for as Mr. Du Bosque sat down he was greeted with hearty applause.

Lieutenant W. P. White, U.S.N., said, with regard to Mr. Dickie's paper, that conditions on the Pacific coast were such that an ordinary torpedo boat could not live outside a harbor. He would like to know against what torpedo boats out there it was proposed to use destroyers? The only place on the coast where there would be any chance to use a destroyer would be in the vicinity of Puget Sound. The same statement would almost apply to the Atlantic coast.

Assistant Naval Constructor Richard M. Watt, U. S.N., declared that the moral effect of torpedo boats, admitted by Mr. Tawresey, justified the existence of the torpedo fleet. While Lieutenant-Commander Kimball, who was the commander of the flotilla, admitted that a single torpedo boat could not be used in daylight, yet according to published accounts of the Manila fight two Spanish improvised torpedo boats started at a distance of 4,400 yards and one reached within 1,200 yards of the flagship before she was disabled. He believed that if a small fleet of boats—only half a dozen—was to start from several different directions to attack a ship, the moral effect would be such that some of the crew of the ship would become rattled and some one boat would be able to get home a torpedo.

John Platt said that was the accepted mode of torpedo attack. Five to eight boats were supposed to operate simultaneously against a vessel. "We are apt to forget here," he said, "in discussing this matter that France has between 300 and 400 torpedo boats, Russia between 250 and 300, and Great Britain about 300 or 400. Mr. Kafer spoke of some of the boats with flat sterns. Now H.M.S. Fame of 300 tons displacement steamed from Sheerness to China unattended, and made the voyage in a perfectly satisfactory manner and arrived out in good condition."

Stevenson Taylor, in the chair, said the war with Spain did not determine the utility of torpedo boats, as they had been used only for purposes for whch they were not intended. He took exception to Mr. Kafer's statement that the boats could maintain high speed for a run of only a few minutes in view of the fact that British boats are run six hours continuously on trial. Nor was it fair to condemn the construction of torpedo boats on account of the failure of some during the Spanish war. No one could claim that the Winslow was sent to do torpedo-boat work. Boilers should not be condemned wholesale because of the failure of some. He recalled the trip of the U. S. S.

Porter around Long Island in about twelve and a half hours, "a marvelous performance for so small a boat," and yet the Porter went to Cuba and came back and had to have all her boilers replaced. He did not believe it was the fault of the boilers but rather of the personnel. "We have been having in use tools which men were not accustomed to handle," he continued. "I learned a short time ago that the boilers of the steam yacht Sovereign, now the Scorpion, had been destroyed practically, at least two or three of them had—she had four. Now you cannot convince me, knowing that the Sovereign ran a whole season and the boilers came out at the end of it absolutely perfect—there was not a leak in them anywhere—you cannot make me believe that two or three months' service on the coast of Cuba in proper hands would destroy those boilers. It is evident that we have not had the right sort of men to handle these particular tools."

Naval Constructor Francis T. Bowles, U.S.N., desired to say "one apologetic word" for the personnel. When the Ericsson in the fleet before Santiago saw Cervera's vessels coming out, she had a distance to run at full power which expended all her fresh water and she had to go on and use salt water. That was the experience of every torpedo boat. The Porter frequently exceeded the limit of her endurance for fresh water, and that had been the case with most of the vessels on the blockade. It was fair to consider that when the performance of the Sovereign on blockade was compared with her trip through the watering places.

John C. Kafer: "I had a talk with the commanding officer of the Scorpion and he said but one boiler gave out, and that was from low water. The other boilers had been performing satisfactorily during the whole trip to Cuba. He was not under the necessity of running over fifteen knots, which he could do very well, and the ship did excellent service at Manzanillo."

Stevenson Taylor, from the chair, added: "I will only say that my remarks about the Scorpion and water-tube boilers were caused by a person saying to me, when I suggested that if we built a certain vessel, of which we were then making a tender to the U. S. Government, that we would put in Yarrow boilers, and asked if that was satisfactory. I was told 'yes, but the Yarrow boilers have given us as much trouble as any other boilers—more trouble than any other boilers, and as to the Scorpion, which you built, her boilers have all given out'—words to that effect. My authority was George W. Melville, Engineer-in-Chief of the U. S. Navy. If those boilers gave out it was not the fault of the builders—that was the only point I proposed to make. I am not an advocate of water-tube boilers, have not got a patent on one, nor have I assisted in the construction of many. On the contrary, I rather advise, in the business with which I have most intimacy, against water-tube boilers. At the same time there is the other side, and it is not fair to condemn water-tube boilers on account of results which have been caused by necessity. I did not refer to chief engineers or assistant engineers, but I know it was impossible for the U. S. Government last April to get the right kind of men to take care of the water on their vessels. I know that it was impossible. They could not get the right kind of men on board of the Scorpion, because the regulations forbid it. Now what can you do? It is not the chief engineer. He cannot watch the water all the while. Nor is it the assistant engineers. But there are other important positions to be filled as well as that of the chief engineer. Therefore when I used the word personnel I had in mind the men in the fire room, the men who attend to the water and such minor duties as pertain to the under corps."

F. L. Du Bosque moved a vote of thanks to Mr. Dickie for his valuable paper.

The motion was carried unanimously.

ECONOMY TEST OF A UNIQUE FORM OF FEED PUMP.

By F. Meriam Wheeler, Esq., Member.

This paper describes a novel arrangement of marine boiler feed pump, consisting of a pair of vertical double-acting steam pumps, arranged on the cross compound plan, with steam cylinders 6 in. and 9 in. dia., and water cylinders 3 1-2 in. dia. and 8 in. common stroke. This pump was so connected on the steam end that either side could be run as a separate pump in case of mishap to the other. The valve gear of each pump was, of course, independent, so that either side could make a full stroke without interference from the other side of the pump. In the paper reference is made to the wastefulness of auxiliaries, the steam consumption of the ordinary duplex Navy feed pump being given as about 120 lbs. of steam per I.H.P. per hour. During tests of less than half an hour each the pump described worked as a compound, with 52 pounds of steam, and when running simple, with the high pressure side only, the consumption was 93.41 pounds. When run compound the initial pressure was 112.5 lbs., and when simple 67.5 lbs. During the tests the discharge pipe of the pump was throttled to put a pressure of about 200 lbs. per sq. in. on the pump cylinders.

DISCUSSION.

Passed Assistant Engineer Walter M. McFarland, U.S.N., opened the discussion by saying the question of increased economy of auxiliaries was of special importance for naval vessels in which any saving of weight was peculiarly desirable—in this case of coal carried. Wonder had often been expressed that pump makers did not adopt some plan, either cross compound or tandem compound construction, to reduce steam consumption of auxiliaries. He asked why the system described in the paper could not be employed with advantage in naval auxiliaries. Another question occurred to him in connection with the proposed new ships for the Navy (the tentative programme for the next Congress), which would probably have water-tube boilers carrying about 300 pounds pressure, with 250 pounds or 260 pounds at the engines. How would the pump makers meet the question of operating a feed pump against these high pressures? Plunger pumps had been suggested, and in a lake vessel carrying 250 pounds pressure had been adopted, in the double plunger form. That would solve the question as far as mere pressure was concerned, but he would like to know how that design would compare with the pumps now in use as regards weight and space occupied; also whether it would be possible to make a successful double-acting pump of the piston type to work against very high pressure.

F. L. Du Bosque inquired if the author had made any experiments as to the relative economy of operating pumps by low-pressure steam omitting entirely the compound system. Glancing over the figures given, the speaker was led to believe that the low-pressure cylinder contributed as much to the economy of the system as the high, consequently it might be well to operate a pump with one cylinder with the initial pressure very low.

Professor Cecil H. Peabody questioned the correctness of calling the pump "cross-compound," as his understanding of the term was that a cross-compound was an engine with cranks set at 90 degrees. He asked whether there was any fixed succession of piston strokes, and how this was maintained. "It seems to me," he continued, "there is no reason why one pump should start at one time rather than another, or in fact that one pump should keep time with another. I must make a criticism, with regard to the statement, made in connection with the test, that certain observations were made electrically and therefore were correct. I do not believe that things done automatically are therefore correct. Usually they are not, unless somebody was careful to see that

they were automatically done in a correct manner. Moreover the tests, I believe, in spite of the assertions made, are too short. Since, however, all that Mr. Wheeler wants to make out is that one pump is very much better than the other it is sufficient to prove that. Unless the pump was run for something like an hour in the condition of the test before the test was made, it is quite sure that twenty minutes would not be enough and I think even then it is doubtful. That is, however, a minor question. There are some figures in the test, too, that I entirely fail to understand. In fact it suggests to my mind the question whether the test was right. The power developed in the high-pressure cylinder is 2.54 horse power and in the low-pressure cylinder 3.07 horse power; meanwhile the speed per minute on each side was forty double strokes. The pumps were working against the same water pressure and at the same diameter. These figures do not correspond. The water end must use up a certain amount of power. It must get it from the steam end. There may be a difference of mechanical efficiency, but not to account for half a horse power, or two and a half out of three."

R. L. Newman said he had decided recently to try compound pumps and had put in one vessel compound pumps of the tandem type, the high and low pressure working directly on one plunger—outside packing. The boilers were of the Scotch type, built for 230 pounds pressure, and the pumps worked very satisfactorily. He considered it probable that there would be further economy in working pumps triple-expansion, either duplex or tandem. Another point he had considered was the centralization of the pumping system and so instead of several separate pumps for fire, bilge, feed, etc., install one or two large triple-compound pumps using say one instead of half a dozen small pumps. Again it was a question whether or not it would be well to go back to former practice and drive some of the pumps from the main engine—revolutions permitting—and have then one or two duplex pumps in reserve.

Passed Assistant Engineer W. M. McFarland, U.S.N., said as to driving the pumps from the main engine Mr. Newman undoubtedly spoke from the merchant marine point of view, while his own training had been from a Navy standpoint. "I simply want to say," he proceeded, "as showing what a radical difference there is in the practice in the two cases, that during the late war when we had a lot of merchantman brought into the Navy and armed for auxiliary purposes, we found that the machinery as put in there was by no means adapted to good use under the conditions that obtained in naval vessels. Ordinarily with a merchant steamer she starts out after things are turned over and runs, even on coasters, for quite a long trip, where all the conditions are perfectly uniform. In a naval vessel she is constantly stopping and starting, and running along at all sorts of speeds, and then lying ready to move, but not moving for several hours at a time. Yet we found complaints constantly from the engineers of those merchant vessels that they wanted auxiliary pumps put in for condensers and various other things of that kind. Then again, of course, Mr. Newman himself made the reservation, that to drive these pumps from the main engine the speed should be sufficiently low to make it desirable. I think so far as the naval practice is concerned that the method we have now gives much greater satisfaction indeed. My earlier experience in the Navy was at a time when all the pumps were driven by the main engine, except tank pumps for feeding the boiler, when the main engines were not in operation; and the ease and comfort of running a big engine on a modern ship where the main engine has nothing to do but turn the propeller as compared with the old one, is remarkable. I thought it was a good time to call attention to the difference between the requirements of the merchant service and of the Navy."

F. W. Wheeler, in replying to the various criticisms, said the tendency was towards stripping the main engines of all pumps, and as far as feed and air pumps were concerned he believed that practice was traveling forward by having them independent. He referred to "the latest Sandy Hook boats" and the "Kaiser Friederich" as examples of vessels in which direct-driven air pumps had given serious trouble. As to tandem-compound pumps, they gave better economy than the two-cylinder pattern, because they were more compact and had less radiating surface. Triple-compound pumps had been used in land practice and found to be economical-working on 27 pounds weight of steam. Centralizing the pumps of a vessel was a move in the right direction, and the pump described was a move in that direction, for instead of having a pair of duplex pumps—or rather a duplex pump—this pump could be cut in half, so that either side could be run, and by speeding up could do the work of the entire machine. As to the regulation of the strokes, the expectation when the pump was designed was that one side would go faster than the other, but on trial both sides ran exactly the same number of strokes. If, however, the stuffing box on one side was tightened up—more friction put on—that side would slow up a little. Professor Peabody had spoken about the difference in horse power. The slippage in one pump was more than in the other. It was also possible that the diagrams were not taken simultaneously. He had every reason to believe in the accuracy of the tests, for the shop where they were tested was noted for careful work. As to the economy of running a pump low pressure, tests had shown that up to a certain limit the higher the pressure the greater economy, which could be explained by the low piston speed and the difference in cylinder condensation between the direct-acting pump and the steam engine. Pumps of the type described had been built for pressures from 275 to 300 pounds.

Third Technical Session.

Stevenson Taylor was in the chair when the meeting was again called to order on Friday, November 11, at 10:40 o'clock in the morning. He announced that the first paper on the day's programme was:

THE STEAM YACHT AS A NAVAL AUXILIARY.

By W. P. Stephens, Esq., Associate.

Commencing with a reference to the practical demonstrations given during the war with Spain, as bearing on the design and construction of naval vessels, the author points to the absence of other than fighting ships in the naval shipbuilding programmes of recent years. He refers then to the rush for auxiliary naval vessels which the Spanish war occasioned. Among such vessels needed was a type, which, divided into three classes, gives: (1) Vessels for sea service as tenders to the blockading fleet or for operations in shoal water; (2) vessels for picket duty; (3) vessels for harbor patrol duty. For such work the "Naval Auxiliary Board" selected ocean-going tugs and steam yachts—of the latter twenty-seven. In the case of the yachts, many alterations in structure and equipment were needful before the vessels were ready for service. Referring to the suggestion that the government should arrange with yacht owners so that yachts would conform in construction and equipment with certain naval requirements, the author dismisses this as impracticable owing chiefly to the improbability of blending the requirements of a warship with the luxurious tastes of a yacht owner in one vessel. References to existing gunboats as too large for the services described, and torpedo boats and destroyers as too fragile and generally unsuitable are made, and a proposition follows for the construction of a special type of vessel. Of this type a vessel not to exceed 800 tons displace-

ment is suggested for sea work as dispatch boat, tender or for picket duty. In single-screw vessels the draught would be 11 ft., and in twin-screw 9 ft. For sea service on picket duty exclusively, a boat of the type would be of 400 tons displacement and 7 ft. to 8 ft. draught. Both of these classes would have a rate of speed not to exceed 18 knots at sea. The third class, for harbor-patrol service, to be composed of vessels of about 200 tons displacement and 6 ft. draught, designed for smooth waters and with a speed of 15 knots. The armament proposed for these classes would be selected from 4-in., 5-in., and 6-pounder rapid-fire guns. Such vessels would cost comparatively little and be always available for immediate service.

DISCUSSION.

Captain Jacob W. Miller, in opening the discussion, said if the money recently paid for auxiliary naval fighting vessels had been expended during the past three years in building suitable ships, better and more suitable vessels would have been available for the patrol, harbor defense, and second line work. The vessels secured were the pick of the steam yachts of the country, a point which should not be lost sight of in discussion. "As to the speed of these yachts," he continued, "the better class were down in the books as about 16 or 17 knots. There was not one yacht in this district, and I dare say it is true in the South and other districts, that could maintain a 24 hour speed of more than ten knots. You could get spurts. These yachts were built for a crew that would work half a day. The owners would go out for a short trip and they would get large speed, but it was impossible to keep it up. There was no berthing room to keep men in good condition, on the yachts, for steady work during the week. Yachts also were not suited, he said, for the rough work of harbor patrol, such as towing vessels out of mine fields, etc. He believed two classes of vessels only were needed for the work under discussion. It was not possible to divide the work of the bay and harbor from the immediate off shore work on the coasts.

Naval Constructor John G. Tawresey, U.S.N., who had served continuously as a member of the Auxiliary Board, said: "At the outbreak of the war the necessity was felt for a large number of small vessels, and the first demand that we received in that particular was for vessels for use as 'eyes to the fleet,' as it was expressed at that time, and under the direction of the Navy Department the Board proceeded to examine and purchase a large number of vessels. To avoid any misunderstanding, I would state that, as far as my memory now serves us, there was not a single one of those vessels bought because the Board considered her of a type suitable for an auxiliary—for work as an armed vessel. We did not approve those types as ones to be built, but we had to examine the vessels right at hand immediately available, and of those we picked what seemed to us the more suited for our purposes. As fighting vessels, every one of them was a make-shift. They were filled with features that were objectionable. There was not sufficient water tight subdivision, and there was not ample protection to buoyancy or stability in any other form. The coal bunker capacity was limited. There were great quantities of woodwork in the neighborhood of the positions where the guns had to be mounted, and, worst of all, the vessel as a whole was a veritable tinder box. I was amazed in walking through the Navy Yard in Brooklyn to see the great pile of woodwork removed from those vessels, and then when you went on board the vessel you would hardly miss it. The Board made the best selection it could from the vessels immediately at hand. They were selected according to the demands of the Department from time to time, vessels for this purpose and the other purpose; but the exigencies of the service caused many vessels bought for one use to be assigned for other duties. Some were sent to Cuban waters to take part in blockades, and consequently in some cases better vessels could have been selected, even from the yachts in the harbor, for certain duty than the vessels actually assigned to that duty. In most cases we were limited in the amount of money, and we selected smaller and cheaper vessels for harbor use than we would have selected if we had known they would ultimately be assigned for duty on the Cuban coast. But notwithstanding all these drawbacks these vessels did perform excellent service and they have shown an efficiency that I do not think any of us could have expected. I would like to emphasize the point brought out in the paper, that while we all admire the Gloucester and the other vessels, and the acts that they have done, we did not improvise and cannot improvise a navy from yachts and tugboats. They served a purpose from lack of other vessels, but there are types, as suggested in this paper, that would be much more suitable. This was a most wonderful war, and one of the most wonderful things about it was how few of our vessels were struck. No one can doubt that if our yachts had been struck by shells they would have been set on fire and capsized, sunk and destroyed quite as quickly as the Spanish destroyers off the harbor of Santiago. There is a field of usefulness for a type of vessel as proposed in this paper. I think we are very fortunate in having our attention called to it. In that connection I would like to go back to the paper that was read yesterday by Mr. Dickie, and suggest that the type of vessel proposed there would fill this field very well, indeed; that if we had a number of those vessels they would have features that in almost every instance would be superior to the qualities and features possessed by the yachts; especially as regards speed, coal endurance, durability and accommodation for the crews and various features enumerated in this paper. There is another matter in the paper as regards the speeds of the yachts, to which I will refer. I think that the majority of the yacht captains deceived themselves as regards the speeds of their boats and that the majority of the owners did not know what the speeds of their boats were. They represented certain speeds, But I will say that the Auxiliary Board discounted these speeds in purchasing the vessels, and that with few exceptions we were not disappointed in the speeds actually attained. We never purchased a boat nominally 18 knots, expecting that she would make 18 knots. I cannot close my remarks without a word in praise of the efficient and rapid manner in which these boats were fitted out in the Navy Yard here and other places. In a war when the events move as rapidly as they did in the late war, a little of that tired feeling that comes from continuous work day and night, a little less promptitude in adopting plans and ordering materials would have led to delay that would have been serious for the Government, that would have made the blockade of the Cuban coast weak and inefficient for a long time, and would have deprived many officers of the opportunity of performing the exploits that we have so much admired."

John Platt said: "I think we are much to be congratulated that the question of the particular kind of boat suggested by Mr. Dickie has been brought before the Society. I would like once more to emphasize the fact that the fast gunboat has not been built at all here and that nothing particularly has been done with it. All the other navies are building them and are building very efficient boats. The boat suggested by Mr. Stephens is one of probably about 850 tons displacement, and he only asks for 18 knots. Well, that is not desirable, as there is no difficulty at all in making a perfectly staunch and strong boat to make 22 and 23 knots. The boat suggested by Mr. Dickie yesterday which he calls a torpedo-boat destroyer is, of course, of a lighter class, and there he was asking 25 knots. On the horse power that he gave he would get more than that, but

he was wise to allow for considerably more horse power than would be needed, so that he could get his 25 knots easily, which is not at all an undesirable thing to do. The British Government built a large number of torpedo boats, as they call them, of this class, which average in speed from 18 to 22 knots, and we could very well start in and build a few of these boats to make 22 knots and keep that up continuously. Say the contract called for 22 knots continuously for six hours and have them designed for this, and they would be very efficient boats. Such boats, I think would be capable of performing the work suggested by Captain Miller, and after that work was done they could be used, if it was thought desirable (they being provided with torpedo tubes) as deep-sea torpedo boats or torpedo gunboats, and for convoying or operating with a fleet of torpedo boats from some base."

Naval Constructor Francis T. Bowles, U.S.N., did not approve of Mr. Platt's proposal for a 22-knot boat. He desired to see something "useful and practical"—a small gunboat that could be guaranteed to make sixteen knots between New York and Norfolk five or six times in succession. Part of Captain Miller's experience with yachts was due to the fact that he had received the small end of the fleet, which was not built for speed; and so many Naval Militia men wanted to go to sea that the captain had to put a 48-hour crew on a 12-hour boat—he was not satisfied with 24 hours. The yacht Eagle was named by Mr. Bowles as a specially successful vessel, which in a trip along the south coast of Cuba generally distanced the Marblehead by about two knots an hour, though the nominal speed of the latter was greater by several knots. He advocated only one size and class of vessel for the work.

Lieutenant W. P. White, U.S.N., fell in with the proposition of Mr. Bowles that a 16 or 17-knot vessel was what was needed, but he believed that inshore work would in time of war be always carried out by emergency vessels—the sea-going tug was adequate. For scouting work fast freight ships, with great coal capacity, would be best. He compared the steamer Yosemite with the cruiser Minneapolis, for such purposes, to the disadvantage of the latter. The "eyes of the fleet" were not intended for fighting. The lack of trained personnel was serious. The Minneapolis had very few trained men for her crew. When she first went to sea during the war there was one machinist in the engine room who had been to sea once before, and some of her machinists had never been to sea. As a question of policy he advocated the development of the fighting fleets, which were the main reliance. Auxiliaries could be improvised, but battleships had to be specially built, and as only a limited amount of money was available it would be better spent on the first line of defence.

Irving Cox dwelt upon the inefficiency of crews of the auxiliary vessels. When a yacht was being built the owner had to be considered primarily and not some future use, but yet the designer sought to make a useful sea boat, which in proper hands would cruise thousands of miles without trouble, as the speaker had experienced. One such vessel had numerous breakdowns after she was converted into a war vessel, and upon investigation he learned that the man in charge of the engine room had no experience with marine machinery, but was simply a machinist when ashore.

Colonel Edwin A. Stevens spoke of the excessive claims for speed made for yachts. He quoted a friend, who had said in reply to an inquiry about his yacht: "She is doing very well, indeed. I have beaten all the 18 and 20-knot boats around New York. The 14 and 15-knot ones bother me a great deal."

Lieutenant W. P. White, U.S.N., was again given the floor to tell what might be done in time of peace, getting ready the auxiliary fleet for war, in the way of inspection, special structural modifications, etc. He referred to the Russian auxiliary fleet running out of Odessa, which consisted of freight and passenger vessels of 7,000 to 8,000 tons. At either end of their route arms and magazines were always kept stored ready for immediate use. The magazines were great iron tanks, which could be readily hoisted in.

R. L. Newman believed that, though auxiliary vessels were very necessary, the country should first endeavor to build a navy—battleships, cruisers and vessels of that type—second to none in the world. With the increase of the Navy there would be an increase in the merchant marine, and so there would always be boats available for coast defense or harbor work in war time. The torpedo gunboat could come later. The sea-going tug was a highly efficient vessel, and likely to be an important factor in future wars.

W. P. Stephens, in closing, said he appreciated that the yachts and tugs were not selected as efficient warships, but because they were the best available. "In regard to the classes," he went on, "I have simply taken the yachts and the services to which they were assigned. Mr. Dickie's boat seems to fill the first class thoroughly. Leaving out the torpedo tubes and cutting down the speed a little it would be almost what I have suggested. That class is now represented by the Gloucester and Scorpion. We have heard the Eagle highly commended. She represents another class—about half the displacement and less draught. Such a boat would be useful for the coast patrol, for shoal work in Cuban waters, but bigger than is necessary for harbor work. The harbor work is the least important, and tugs might be converted for that purpose, but it can be done much better by a boat properly designed; a reliable boat, not of high speed, with not much coal capacity, seaworthy enough to go outside the Hook or make short passages at sea, but not to stay at sea like the coast patrol. Mr. Platt says 22 knots could be easily got. That is quite probable, but it would be better to be contented with a speed of not over 18 knots and let the other four knots go into simplicity of the engines, so that they could be handled by such crews as can be had. Trained crews are a necessity, but we are not going to get them in adequate number, so the vessels should be capable of being handled by such men as can be had. The auxiliary and the battleship have been spoken of. We all recognize the necessity of battleships and want more of them, but the auxiliaries we must have. In the case of the yachts, indeed, the money paid out would have gone a long way toward building a battleship, and there is comparatively little to show for it in the converted yacht fleet now. It would have been better if the money had been put in advance into a fleet of small gunboats. If half the cost of a battleship had been so expended we would be much better off to-day. The torpedo gunboat has been spoken of. It is a useful tool, but I believe the plain, simple gunboat of moderate speed, without torpedo tubes, and with the other requirements I have indicated, would be much more to the purpose than anything in the torpedo line at present."

DESIGNS OF THE NEW VESSELS FOR THE U. S. NAVY.

By Chief Constructor Philip Hichborn, U. S. N.

In this paper, which is of great practical value on account of the numerous scale drawings that accompany it, the Chief Constructor of the Navy has outlined the principal characteristics of the ships recently contracted for, viz.: Three battleships, four coast-defence monitors, sixteen torpedo-boat destroyers, twelve torpedo boats, and one practice sailing ship for the Naval Academy. He refers at the outset to the fine performances of the various ships of the Navy engaged in active service during the recent war, which have influenced the country, through Congress, to respond generously to naval needs. In sketching an outline of the battleships, the author

calls attention to the proposed installation of underwater torpedo tubes exclusively, and to the probable substitution of Krupp for Harveyized armor, and 12-in. guns using smokeless powder for the present type of 13 in. Speed, coal capacity, and the fact that with the advances in this direction there has been no sacrifice in the direction of draught, are in turn noted. The new vessels, indeed, will have an advantage of from 18 in. to 24 in. in draught over vessels of the same class and size in Europe. A description of the new monitors is followed by details of design of the torpedo boats and destroyers. A novel feature of the destroyers is the introduction of bilge keels, decided upon as the result of experience at sea with even the largest torpedo boats, which have been found to wear out crews in a few days, principally by excessive and lively rolling. Bidders did not look favorably upon this feature of design, because bilge keels were considered an uncertain factor in the high speed required, but the keels were retained in all contract specifications. The practice vessel for the Naval Academy—U.S.S. Chesapeake—now under construction, will be propelled by sail power, but will be fitted with an electric light plant and numerous auxiliaries, and will be equipped with a modern battery of rapid-fire guns.

In the absence of Chief Constructor Philip Hichborn, U.S.N., the paper was read by title by Secretary Bowles, who suggested that if there was to be no discussion on the paper, a very desirable discussion would be on the usefulness of monitors, "and whether they are worth while."

DISCUSSION.

Lieutenant W. P. White, U.S.N., led off by calling attention to the need of adequate coal supply in the battleship. The absence of the Massachusetts at the Santiago fight was due entirely to her lack of coal capacity, and to her having to go forty miles to coal. In battleships the space in the center just above the water line, now used for officers' quarters, might be used in time of war for bunker space. The officers could be accommodated in the after part of the ship, and the Admiral's and Captain's staterooms put up on deck—in the merchant service the captain's cabin was usually under the forward bridge. He suggested also modifications and extensions in the living spaces for the crew. Too many boats were carried on battleships, in his opinion, and he cited the Oregon, which left all but two boats at Key West during the Cuban operations. As to monitors, he had observed the Amphitrite while being towed from Hayti to Hampton Roads, and "she wabbled around like an egg shell on top of the water." They had not enough living space for crews and could not make any speed at sea. For their proper work of harbor defense, monitors were only floating forts, an expensive form of fortification, which had no purpose that could not be better served by a fort on shore.

Captain W. C. Wise, U.S.N., declared he was a "great monitor man," having had five years' experience with a monitor. "I regard to-day the Puritan as the strongest fighting ship in the Navy," he said, "and in her I think I could lick any battleship we have got, and I would not hesitate to try it."

A member, interrupting: "In a harbor?"

Captain Wise, U.S.N.: "No, sir! at sea, thank you. I had the Amphitrite. She went to sea about three years ago in a gale of wind. She was a most perfect sea boat then, and she proved her capability of riding safely out a storm in which the Maine lost men overboard, and other ships lost a lot of men overboard. Some one asked me if we could fight our guns in a gale. No admiral and no captain is going to fight his ship in a gale of wind. No battle has ever taken place in a gale of wind. I think we ought to have about twenty monitors. They are the true defenders of this country. You can take five monitors and put them off Romer Shoals, and the harbor of New York is perfectly protected, and the Navy can do it. Of course, Mr. White has reference to the Amphitrite, the Puritan and the Terror. They have got old and obsolete engines in them. But the Monterey is the right type of monitor, and I think if you give us twenty more Puritans we will take care of the defense of the country."

Professor C. H. Peabody was surprised to find, during the war, that there was a real use for the old 15-in. monitors. A warrior friend of his had told him that he would feel a great deal more comfortable if one of the old monitors was anchored in the harbor at Boston. It had given him great pleasure to know that his friend felt comfortable when the monitor came in. The speaker then expressed his disappointment that there was not a more active discussion of the Chief Constructor's paper—the most important paper in many respects. As a layman he felt it was hazardous to express an opinion, but there were members of the construction corps present competent to express opinions. He did not know whether there was a corps spirit which made it inadvisable if not improper, to discuss the subject. He noted in the design that the armor belt was carried to the bow—the full thickness carried pretty well forward, and then the belt was diminished by steps, carrying a very considerable thickness very well down toward the bow. "Now it appears that there are two methods which have been used in navies," he said, "for protecting the displacement and stability; they are by heavy armor belts near the water line, or else by an inclined armored deck behind. Sometimes they are used in combination. The English, notably, have used it of late years. It appears then that we could have either a heavy armor belt, depending entirely upon it, or else a thin armor belt, with inclined deck behind. On these ships surely for a considerable length of the ship we have both; that is, we have a heavy armor belt, with inclined deck behind. I want to ask if that is necessary. There was a remark made and insisted upon by a good number of the Society, I think both those in the service and out, and that was the undesirability of having such a variety of ships as we have in the several classes, notably in torpedo boats, where we have, perhaps, two or three of a kind at present. It seems to me that standardization, which may be very important for many things, is likely to be unfortunate in many cases. What I know about standardization is that you no sooner get a standard than you wish you had another one, and if you insist on adhering to your old standard you find you have made a mistake. But the English, in building ships in large numbers, have made some standards. They have eight or ten or a dozen, or perhaps more, in some of the smaller classes which are substantially alike. Here comes an opportunity—fourteen torpedo boats and sixteen torpedo-boat destroyers; I believe there would be four or five in each class. Now, was not this the best opportunity to insist on having fourteen of one kind and sixteen of another, and then you would have a standard for that class, at any rate."

Naval Constructor J. J. Woodward, U.S.N., explained that heavy side armor in combination with a protective deck, was used to meet the advances in explosives. With high explosives such as melinite the local destructive effects were very great, and a projectile striking thin armor would be likely to project fragments of the armor into the interior of the vessel, where the protective deck would receive and deflect such fragments and so prevent serious structural injury. His reason for thinking that this was the "proper justification" for such an arrangement of armor was that the foreign admiralties had for several years been providing their ships, throughout their vitals, with what amounted to two protective decks. The earlier ships, where higher explosives were not a factor in design, were a box

with a top and sides, but without any bottom, now an armored box with tops and sides and bottom was used.

William A. Dobson spoke about the structural strength of torpedo-boat destroyers. Mr. Dickie in his paper had recommended that some of the power should be sacrified in order that the weight might be placed at the disposal of the naval architect. In the new U.S. Navy destroyers this had been well considered along with the question of speed. Mr. Dickie had instanced the case of a British destroyer which had come into the Union Iron Works in a very deplorable condition. She was going north, and her stringer plates were entirely sheared through on one side and the butts of the sheer strake were started. In order to obviate this the Department had worked in a stringer plate of nickel steel, and made the sheer strake also of nickel steel, and the intercostal plate on the longitudinal bulkhead of nickel steel; the whole connected by bracket plates and secured to the frames, forming a large channel section, which gave ample strength in the top member of the equivalent girder.

Colonel Edwin A. Stevens suggested the inquiry, whether the conditions prevailing at Santiago were sufficiently long to give a hint as to the probable number of hits to be expected in future engagements? The Spanish ships had not been hit to any extent with large shot. If the conditions there were the probable ones, was it necessary to give so much of the capital placed in the hands of the designer to very heavy armor, necessary to keep out 12 in. and 13 in. shot?

Lieutenant W. P. White, U.S.N., said: "It would seem that the conditions of firing with great guns at Santiago were not normal conditions. Why they were not so I am not able to say. It may have been to some extent due to the smoke, which did not prevail with other ships of war; or the rapidly changing range. Whatever it was, I don't know. But the 13-in. gun ought to hit as often and, in proportion to the fire, oftener than the 6-pounder. It has a very much better trajectory, and it was a great surprise to the officers of the Service that more was not heard of the larger gun. Thirty per cent of the shots fired under those conditions ought to take effect somewhere on those ships. About three per cent. took effect."

Fourth Technical Session.

President Clement A. Griscom was again in the chair when the final session was opened at 2:15 o'clock on Friday afternoon. The proceedings commenced with the reading of the paper entitled:

METHODS OF SECURING WATERTIGHT WORK.

By Asst. Naval Constructor H. G. Smith, U. S. N., Associate.

This paper describes the methods employed in making practical tests for water tightness in naval vessels, and also the materials used for stopwaters and the way in which they are used. It gives also the results of tests of the efficiency of such materials, and concludes with the actual results of hydrostatic tests of compartments on the United States ships Brooklyn, Iowa, and Alabama. Leaks that develop under test the author classes under two heads: (1) Initial leaks; (2) induced leaks. Initial leaks are found with any head of water and are due to imperfect workmanship. They always occur, can usually be stopped and then give no further trouble. Induced leaks occur only with a considerable head of water, caused by deflection of the material, with consequent breaking of the calking and opening of water-tight joints. These depend upon the stiffness of the material, and while they may not appear with one head of water they may quickly appear as the pressure is increased. They indicate defective design. For joints not accessible for calking, after the material is fitted and riveted, the following materials for stopwaters have been tried: Tarred hemp felt, plain or soaked in red or white lead; canvas soaked in red or white lead; sheet rubber; sheet lead; red lead putty; hempen or lamp wick gaskets, soaked in white lead; asbestos; lead wire, and in some cases, copper wire. Where joints are close fitting (1-2 in. thick or under) and can be well drawn together in riveting tarred hemp is generally used. Where parts are rigid and stand apart when riveted felt is useless, and a thick layer of plastic substance, such as red lead putty, is used. Rubber, lead, canvas, asbestos, etc., are used principally in connection with pipe work. Results of several rough tests showed that for durability, canvas soaked in red lead, and red lead putty excelled. Importance of having the inner bottom thoroughly water tight was strongly emphasized when the U.S.S. Brooklyn grounded in the Delaware River in January, 1897. She lay nine days with outer bottom torn open for 126 ft. of her length, and the inner bottom subjected to a pressure head of about 22 ft. of water. No damage nor leakage was observed. Maximum deflection of inner bottom was at first 3-4 in. and gradually increased to 7-8 in. Bottom plating was not shored down. For a protective deck of three thicknesses "which always gives trouble," the author recommends forcing red lead putty between the layers throughout the whole length, or calking completely underneath as well as on top. In conclusion, he makes these recommendations: (1) Fitting rigid bracketing to all stiffeners on bulkheads below the water line; (2) Fitting of double bounding and staple angles to such parts of all bulkheads as may be below the water line; (3) Fitting of a vertical stiffening bar or double staples on all watertight floor plates of a certain size, except where the plate is in direct line and adjacent to a bulkhead above; (4) Fitting of the protective deck in two thicknesses instead of three; (5) Fitting of all plating behind armor in one thickness instead of two; (6) The use of double riveted lapped butts and seams, instead of strapped butts and seams, in case of the inner bottom, platform and splinter decks and all bulkheads; (7) As an alternative to (6) the fitting of a stiffening far along the seams in the case of all light flush plating fitted with straps. These would entail an increase of weight, which could be taken care of by a readjustment of scantling weights, or by increased displacement.

TEST OF THE STRENGTH OF A LONGITUDINAL BULKHEAD SEPARATING TWO ENGINE ROOMS.

By Naval Constructor J. J. Woodward, U. S. N., Member.

This was carried out on the battleship Illinois under construction at the Newport News yard in accordance with a clause in the specifications for the construction of the battleships Kearsage, Kentucky and Illinois. This required that all water-tight compartments should be tested by filling the compartments with water under a head. The most important bulkheads were the center line longitudinal bulkheads between the engine rooms and fire rooms of the vessels. The head of water to be used for the test was 5 ft. above the normal load line, corresponding to a water level of 28 ft. 6 in. above the keel. As the workmanship in all three vessels was entirely satisfactory it was decided to apply the test in one ship only to determine whether or not the scantlings as designed were sufficiently strong. The engine room bulkhead of the Illinois was selected, and as the volume of one engine room was so great that to have filled it would have strained the vessel (she was on the blocks in the building slip at the time) a wooden cofferdam of 5 in. plank was built in the port engine room about 3 ft. 9 in. from the center line bulkhead. The hydrostatic head was obtained by using a small

stand pipe connected with the water space within the cofferdam through a hole in the protective deck. During the first tests a good deal of local distortion was observed until a head of 22 ft. 4 in. was reached, when, owing to the buckling of some brackets, the test was stopped. Additional stiffening was worked in, and a second test made with the maximum head, for a long period, after which various stiffeners were found to be strained beyond their elastic limit. Further structural alterations were then made, and a final test proved entirely saisfactory, and accordingly the similar bulkheads on the other ships were reinforced in a similar manner. In his observations the author calls particular attention to the class of bulkheads under consideration. In this class satisfactory general strength to prevent collapsing is the chief requisite, as is the case with the ordinary bulkheads of a man-of-war, and in which a slight amount of leakage through rivets when under the maximum test is not a matter of any moment. For those bulkheads in which *absolute* watertightness is necessary, as in trimming tank bulkheads, etc., where, in addition to satisfactory general strength, there must be such local stiffness as will prevent any leakage whatever, under all possible pressures, the method of nalysis that the author proposes, will apply only to the consideration of general strength, and in such cases experience of past practice will be a determining factor. He also expresses the belief that for bulkheads introduced to prevent collapse and not for *absolute* watertightness, wider spacing for stiffeners than the customary 30 in. is permissible, increasing indeed to 4 ft., with accompanying increase of strength of stiffener bars. The additional use of belt stiffeners is also advocated in bulkheads in which length is relatively greater than depth, and which are subject to considerable heads of water pressure. In making his calculation the author has employed such a method as will permit of the determination of scantlings in other generally similar conditions.

The two preceding papers were read in succession, so that the following discussion could be along the lines of both, the subjects being so closely related.

DISCUSSION ON TWO PRECEDING PAPERS.

Naval Constructor John G. Tawresey, U.S.N., in opening the discussion referred to Mr. Smith's paper and said he could not refrain from expressing his surprise, and even sorrow, that a member of the Society and a naval officer should propose to divide water-tight bulkheads into two classes—"one that must be water-tight and one that may leak." He understood that in testing for water-tight work small leaks would be found and corrected, and it was not always necessary to repeat the test on this account. "But how are we to strike a target if we do not aim at the bull's eye?" he exclaimed. "A bulkhead, at least under the static conditions of test, such as described in these two papers, appears to me an unsafe bulkhead to take the pressure due to the skin of the ship being punctured and the stress in a seaway. If we were looking at it more in a historical point of view we could divide bulkheads into these two classes—bulkheads that are water-tight and bulkheads that leak, and I am sorry that there are many of them in the second class; but I do not think that turning to the future we should design them or test them with that in view at all. A bulkhead that can leak a little will leak a little more—probably will leak a great deal more." A reading of the paper, he went on to say, might give the impression that the Alabama was a poorly constructed ship, so far as watertightness was concerned, but exactly the contrary was the case. She was probably one of the best ships constructed. Leaks were not an affliction known exclusively in the Navy. In merchant vessels many leaks not found were not sought after. In merchant vessels it was often considered sufficient that the outside plating should be water-tight, and even this was not aways the case on launching. Navy vessels were much more difficult to make water-tight. Subdivision was carried much further than in merchant vessels, and then the system of ducts, ammunition hoists, etc., cut up the bulkheads considerably. He instanced one case in which a bulkhead had not a single stiffener left intact, and in fact the bounding angle had been chipped in places to get room. Such a condition invited disaster. Draughtsmen were, in the speaker's opinion, largely to blame. The principles of laying out water-tight work were not sufficiently understood, and many men also in responsible positions did not put into practice what they knew. Another criticism he had to make was concerning countersunk rivets. There was no excuse for not having the point of a rivet water-tight; it was usually the head which gave trouble. He had used successfully countersunk rivet heads to secure water-tightness, and had designed to have the heads calked. It was much more difficult to get at the head of a pan-head rivet to calk it than a countersunk rivet head.

Professor Cecil H. Peabody did not think the necessity and importance of such experiments were sufficiently appreciated, especially by the people, as they ought to be, for the reason that people could not see when a ship was finished that there was anything at all commensurate with the expense incurred in making a compartment strong enough to withstand pressure. It would seem that a logical thing to do would be to make a series of experiments, covering sufficient ground, so that the data upon which calculations should be based would be sufficient. Then with appropriate treatment, the information could be put in such shape that one could infer from positive knowledge in one case very closely what might be obtained in some other case.

R. L. Newman recounted a common experience on the Great Lakes, a boat sailing from Lake Superior, carrying possibly 250,000 bushels of wheat, would get aground coming through the canals and puncture several holes in the bottom. Then protection would depend entirely upon the inner skin. There were cases in which the vessel came through this ordeal and delivered cargo at Buffalo, having damaged only 25 or 30 bushels of wheat. "We rely principally upon our longitudinal keelsons and our tank tops butted with channel butts," he explained, "we avoid, as much as possible, all joints which would involve calking. Our marginal plate is, as a rule, flanged to the skin of the ship. Also we use collision bulkheads."

John C. Kafer, referring to a remark made by Mr. Tawresey with reference to two kinds of bulkheads, said: "If he would remember that a bulkhead is made for one particular object in one case, and for a different object in another case, probably he would not object to whether it leaked or not. The bulkhead in a vessel is usually made to keep out the bulk of the water; that is to keep the water from rushing in and sinking the vessel. That is the chief object of the transverse bulkhead. In a war vessel where it is necessary to have a bulkhead absolutely watertight, there it is necessary to be very careful indeed. I would not care in a ship whether a bulkhead would leak a barrel of water an hour or not, provided I could keep the mass of it out. It is the strength of the bulkhead particularly that we want to look after. It would be perfectly permissible to have two kinds of bulkheads, some that are water-tight and some that are not. There is no necessity for a builder going to the care of making a bulkhead absolutely water-tight, where one that is practically water-tight, that will not leak more than the pump will take care of, would be sufficient."

Mr. Tawresey in response said: "I am not objecting to two kinds of bulkheads. I am objecting to two kinds of 'water-tight bulkheads.' I do not object to a trifling amount of leakage; but it appears to me that we are exposing ourselves to great danger by

taking a bulkhead that leaks any appreciable amount under the static conditions of test; we expose ourselves to the danger of its collapsing altogether at sea. Of course it is usually said you can go down and shore them up."

F. L. Du Bosque said in early days of the construction of the Navy water-tight bulkheads were a source of constant trouble between builders and the Navy Department. The difficulty at first arose because the Department could not accept the standard practice for making water-tight work in the merchant service. Naval vessels, he said, were divided into a great many compartments, and they called for the extensive use of staple work. In the merchant service it was customary to make this staple work tight by means of canvas and red lead. The whole difficulty had been solved, by the admission of Mr. Spear, through his tests, that absolute water-tightness could be accomplished by red lead. As to rivets—the objection to soft rivets. It should not be forgottent that in driving a rivet sometimes the plate was cold as ice, and at other times too hot almost to touch. For this reason soft rivets were used, as the rivet cooled off very quickly and became hard, and in winter time in driving rivets they cooled so rapidly that they were set up cold. As to stiffening bulkheads he suggested that, "a good deal of lightness could be saved" if a different section of stiffeners had been used. A bulkhead could be made much stiffer and as cheaply if the Z bars were replaced with a proper section of bar, of greater width and of greater area on the outer edge. In reply to an inquiry the speaker said the well-known angle-bulb would seem to accomplish the result.

R. L. Newman by way of comment said: "I do not think that the last speaker's remarks are quite correct as to our relying in the merchant service on canvas and red lead for water-tightness. We have inspectors who follow the work very closely, and they absolutely decline to allow the use of either tar paper or red lead. I have been in the unfortunate position of endeavoring to get permission to use it. We had to obtain our tightness entirely by calking. I have seen the work turned out for the Government and also for the merchant marine, in water-tight work, and so far as we are concerned, both practices are coincident."

Colonel Edwin A. Stevens inquired what, in the Service, were the assumed conditions which a bulkhead structure was supposed to meet. The British Bulkhead Committee, as he recollected, had recommended that the stiffening should be considered as the frame work, the plating over that adding absolutely nothing to the power of resistance. He related an experience with a very shallow section of bulkhead, which seemed to be strong and well proportioned, and yet gave astonishing results. The attachments to the skin were entirely inadequate to have stood a head of water four or five feet above the water line. He asked what—under the assumption of a five foot head, such as was used for a longitudinal compartment—was the factor of safety?

Naval Constructor Francis T. Bowles, U.S.N., referring to a criticism made, said that draughtsmen were not so much to blame for the difficulties in securing water-tightness as engineers and electricians who came along and drilled a bulkhead full of holes after it had been made thoroughly stiff and tight.

Naval Constructor J. J. Woodward, U.S.N., discussed at considerable length several propositions in Mr. Smith's paper relating to the construction of protective decks.

Assistant Naval Constructor H. G. Smith, U.S.N., in closing the discussion, said that on the Brooklyn an average of five men were constantly employed for more than fourteen months in securing water-tightness throughout the ship, and in later ships, the Iowa and Alabama, where a great many more compartments were tested, the amount of work was increased. As to countersunk rivets he had found that this shape of head was more liable to leak than the pan head; and the countersunk head when driven nearly always projected from the hole, and it was necessary to chip off the head before it was calked. Pan heads could be calked by special tools adjacent to the heel of the bar. He recommended doing away with the countersunk head, not so much to replace it with the pan head, but because a thin layer of tar hemp-felt could be applied where it was used. As to finding the amount of stiffening necessary on a bulkhead, this would have to be ascertained in each case largely by experiments.

AN ELECTRICALLY OPERATED 150-TON REVOLVING DERRICK.

By Walter A. Post, Esq., Associate.

This paper contains a complete description of one of the largest jib-cranes in the world. It was recently constructed and put in operation at the Newport News ship yard, for handling heavy armor plates, marine boilers and other great weights in fitting out and repairing ships. A 100-ton sheer legs alone had previously been used for such work. The new crane was designed to conform to these requirements: Capacity to lift the heaviest single weight; a large field of operation and absolute precision within this field; a location accessible from any part of the yard; and economy in respect of cost of construction and operation. The derrick is located on a pier 700 ft. long with deep water and ample mooring space alongside. Piles form the foundation, which is filled in to afford protection from the teredo. The jib can be raised and lowered and the derrick revolved so that the hoisting block will describe circles of 88 ft. and 207 ft. as the respective circuits of operation. The maximum load of 150 tons can be handled within a ring having maximum and minimum diameters of 147 ft. and 88 ft. respectively, and loads of 70 tons can be handled at any angle of jib. The maximum elevations, above mean high water, for the hoisting hooks in the high and low positions of the jib are 118 ft. and 69 ft. respectively. The derrick proper revolves on conical steel rollers on a track 36 ft. in diameter, which is carried on top of a circular steel tower secured to the pile foundations. The derrick is operated by electricity, various motors for revolving the movable structure, raising or lowering the jib, and for hoisting, are conveniently located in the housing, which also carries the counter weight or ballast. Various results of tests are included in the paper, the maximum in the several operations showing: Hoisting, net load, 152,320 pounds; speed, 6.05 ft. per minute; moving jib from lowest to highest position, 6.9 minutes; complete revolution with load of 300,160 pounds, 3.38 minutes.

This paper was read by title, as the author was not present, and no discussion followed.

STABILITY OF A BATTLESHIP UNDER DAMAGED CONDITIONS.

By Prof. C. H. Peabody, Member.

This paper is an account of the results of model experiments with a battleship of these general dimensions: Length between perpendiculars, 368 ft.; beam, 72 ft.; normal draught, 23 1-2 ft.; height of main deck above normal water line, 11 ft. The investigations were intended to show the effect of such injuries as would admit water to compartments on the protective deck outside of the armored transverse bulkheads, and also of flooding certain of the compartments below the armored and protective decks. The model was of wood on a scale of 1-4 in. to the foot. It was made in two parts representing the lower and upper body of the ship; and with the inclining apparatus in place it was ballasted so that it floated at

the proper water line, and so that it had the proper metacentric height. Blocks representing the parts which were supposed to be laid open to the sea were cut out, and lead weights fastened to compensate for the wood removed. The initial inclination for a given condition was then determined and also the change of trim, as well as the new water line. Inclining experiments were then made to determine the initial stability at various angles of heel. To properly understand the results the use of diagrams is of course necessary and these accompany the paper. In general it was found that extreme conditions were shown to develop dangerous effects. The fact that so extensive injuries are unlikely, says the author, show that the designer provided agrainst all probable conditions, except the effects of large submarine mines.

DISCUSSION.

Naval Constructor J. J. Woodward, U.S.N. in criticism said all the center superstructure in the ship was entirely neglected. In action the superstructure would not be intact, as the gun port shutters would be open, and probably there would be shot holes through the outside plating. In time of peace, however, a serious accident might occur in one engine room, and the ship go under 15 degrees. It would still be possible to close the gun ports in the superstructure, and thus render that part of the ship practically as intact as the forward and after ends above the protective deck. The addition of the superstructure would, in his opinion, make important changes in the stability curves.

John C. Kafer spoke about the effect of longitudinal bulkheads, and referred to the previous speaker's assumption that by having a longitudinal bulkhead it would be possible to operate the engine on one side after the other side was damaged. "But if the ship turned over," he said, "it wouldn't be of much use. I am dead set against longitudinal bulkheads, because if the stability is not sufficient, all your bulkheads will be of no use; but your engine will run just as well under the water as above the water for a short time. at a moderate speed. I am opposed to the longitudinal bulkhead, and I am glad that Professor Peabody has brought it out so prominently here, to show the danger of having one side of the ship filled with water with nothing on the other side. It is a great deal better to have the ship go down on an even keel, as he has shown here with his model, and I do not know of anything that is more dangerous in a ship with very little stability, as is the case with many of the merchant ships built now, than a longitudinal bulkhead."

Naval Constructor John G. Tawresey, U.S.N., said that a longitudinal bulkhead that would cause a ship to capsize was bad, but it had been the custom to investigate that question in designing ships, and he believed few vessels would be found fitted with a longitudinal bulkhead where the flooding of one or even two compartments on one side would cause the vessel to capsize. If all one side of a ship was flooded she was bound to capsize. The way in which H.M.S. Victoria foundered was pretty well understood now. The first newspaper accounts alleged that the ship had turned over because she had a middle line bulkhead, and consequently it had been very popular for a week or two to jump on the home ships. Having taken a special course in naval architecture at the British Naval College, when this matter was under consideration, the speaker had special opportunity for getting exact information. It was well known now that the ship was not lost in that way.

Professor Cecil H. Peabody responding said the suggestion of Mr. Woodward was a good one and worth carrying out, but the experiments had been made without the superstructure for the very reason stated by Mr. Woodward—ports would be left open in action. He was quite familiar with the reasons for the existence of the longitudinal bulkhead, and it was clear that if the flooding of one compartment on one side would put the ship in a dangerous position, the flooding of two compartments (athwartships) would rectify that difficulty. The question was whether the flooding would be done at the proper time? He understood from the statements made, that in the new battleship designs the filling of two compartments on one side of the longitudinal bulkhead would not cause the ship to capsize. In the case discussed in his paper—unless the model experiments were with grossly different conditions from the ship itself—it appeared as if the ship would be almost certain to capsize, if two compartments on one side were filled.

TOPICAL DISCUSSION.

President Griscom now called attention to the topical discussions on the programme, and said that on account of the amount of time which had been consumed in discussions of papers there was little time left. Under the circumstances it was thought best to limit the discussion to the first question, viz.: "Under the circumstances of the blockade at Santiago which was the more economical method of maintaining the boilers in readiness for immediate action—banking the fires or keeping them spread but very thin?"

John C. Kafer informed the members that he had invited Chief Engineer Milligan, who had been Chief of the Oregon, to attend the meeting and give his experiences. Chief Engineer Milligan was unable to accept the invitation, as he expected soon to go to sea and was then at Hampton Roads. He, however, had written a letter to Mr. Kafer which reads:

LETTER OF CHIEF ENGINEER R. W. MILLIGAN, U.S.N.

"On the Oregon we kept our fires spread and thin. I did that more for mechanical reasons than for anything else; that is, to save the boiler from cold air getting in and striking the tubes. We consumed from twenty-four to twenty-seven tons per day. It must be borne in mind that the engines were used frequently to maintain our position, there being about 200 fathoms of water, in which we could not anchor.

"The Iowa kept nearly all her fires banked and enough spread to handle engines. She always (at noon, when we all signaled to the flag-ship, the coal burnt and amount on hand) consumed from four to six tons more than we did. We had to use our bleeders frequently, and, of course, there was a waste. I would say banked fires would be more economical on coal alone, but under the circumstances I always said 'damn the economy; efficiency is what we want,' and my actions were governed accordingly.

"Difficulty in maintaining fresh water in boilers varied on different ships. You might say it was a local question. None could be had from shore or any other source except the ships themselves. It depended upon the number of leaks, what I call illegitimate losses, and the peculiar ideas some medical officers had about the purity of distilled water. All our evaporators want to be increased about 50 per cent. Those furnished to the Oregon would make the amount they were rated (5,500 gallons per day) but the water showed considerable salt under nitrate of silver test. Still we never had any trouble among the men from drinking it. Our doctor passed it, but with the remark that it was very bad water. Other doctors insisted on the water showing no salt at all, but that would decrease the output of the evaporators fully one-half, as they had to be run so much slower.

"I noticed on ships where the distillers were some height above the evaporators that better water was made, and would recommend twenty feet if possible. Only the distillers need be there; the pumps, etc., could be down alongside the evaporators so as to reduce the number of men to run the plant. The Oregon was remarkably free from leaks, but she would use about 2,000 gallons per day to make up losses in feed.

"We had no trouble with our machinery. From all I can hear of other ships, condenser tubes gave most

trouble. The remedy is to use heavier tubes, nothing lighter than No. 18, B. W. G., and No. 17 would be better. In all the new ships there is a great deal of auxiliary machinery seldom used, but in an emergency all is used. Not being used it is liable to be neglected. We had a well established routine to move all this machinery every day, and if for any reason it could not be done, the reason was entered in the steam log. If this is attended to, I see no reason why any difficulty can occur. We had hydrokineters in our tanks, and always kept feed water at the constant temperature of 140 degrees. No drains led into the feed tanks except from traps of evaporators; all other drains either led to auxiliary or main condensers. Some ships have all the drains discharge into feed tanks. This keeps them too hot and gives trouble. I forgot to mention that nearly all ships had trouble with cold salt water copper pipes, from pitting. This is easily overcome, however, by sweating soft patches on; had some on the Oregon patched nearly a year and gave no trouble. Where salt water was used in boilers their crown sheets invariably came down. Quite a number were crippled from this."

After reading the letter Mr. Kafer said, in his own experience, banked fires were more economical, but in a case of this kind economy did not figure at all. It was a question of making the vessel more or less efficient, and there was no question in his mind but that it was better to keep the fires spread, and have them ready to "go ahead" at a moment's notice.

Passed Assistant Engineer Walter M. McFarland, U.S.N., read a hasty abstract of the engineer's logs of the Santiago vessels, which he said needed revision before being made a part of the proceedings. He agreed with Mr. Kafer that there was an enormous advantage in having the fires spread; "because everything was ready then to jump at a minute's notice."

John C. Kafer added that Mr. Milligan had told him with regard to the Santiago fight, that, when the ships came out, within fifteen minutes after the signal was given, the Oregon was ready to go "full speed ahead."

RESOLUTION BY LEWIS NIXON.

Lewis Nixon now offered a resolution which had been suggested by the discussion of some of the papers. "It is but a step from the loss of a ship at sea to the loss of life at sea," he said, "and I think it is to a society such as this that the traveling public must look for suggestions and methods that aim to save life at sea, and to inspire confidence in the sea-going public. The lack of appliances for saving life, or their absence or both, have led to numerous horrors, some of the details of which are fresh in our minds from very late disasters, and it would seem that a discussion of such appliances should form a part of the proceedings of our next annual meeting, not only from the fact that they are of interest to us as naval architects, but that it is a duty that such a society as this owes to mankind. Since the earliest time, so far as I know, there have been practically no advances made in the method of saving lives at sea; certainly nothing commensurate with what has been done in other directions. Some people have told me that in a howling gale it was of no use to make an attempt to save people. However, that is cowardly and we might as well dismiss any such idea as that. In the methods of handling weights, and in being able to apply power to handling boats and other appliances looking to the safety of life at sea, the advance has been so great that it certainly seems to me that the troubles that arose in handling old fashioned sailing cutters, on our ships of war twenty years ago, were far greater than the conversion of the smoking saloon into an ark of refuge for the entire crew and passengers. However, I simply wish to offer a resolution, and I beg therefore to offer it: "That papers be invited upon the subject of life-saving at sea for the next annual meeting and that two such papers be selected by the Executive Committee for publication and discussion."

Naval Constructor J. J. Woodward, U. S. N., seconded the motion and it was unanimously carried.

CLOSE OF THE TECHNICAL SESSIONS.

Votes of thanks were then passed to the American Society of Mechanical Engineers for the use of the auditorium, to the President of the Society for his courteous conduct of the meeting, and to Secretary-Treasurer Bowles. In putting this last vote the Chairman gracefully referred to the labors of Mr. Bowles, which were distributed over an entire year in preparation for the meeting, and this vote was the occasion of a hearty demonstration of good will and appreciation.

Then the sixth annual meeting adjourned without date.

Social Features of the Meeting.

As is customary at the gatherings of the Society, the professional programme was followed by the annual dinner, held at Delmonico's on Friday evening, November 11. More than one hundred members and guests were in attendanace, and for their edification a list of toasts and speakers to respond was arranged. These were, "Our Navy, It Has Justified Its Existence and Glorified the Nation," H. D. Goulder; "Our Commercial Marine, Its Development and Extension is a National Necessity," Senator George F. Edmunds; "The Naval Militia," Captain J. W. Miller; "Naval Architecture," Lewis Nixon; "Marine Engineering," W. M. McFarland, and "Our Manufacturers," Theodore C. Search. Secretary Francis T. Bowles said the final word in response to a very hearty call from every part of the room. He predicted a great expansion for the American marine (naval and mercantile) and referred to the results which would be acomplished by the members of the Society.

While the general meeting was in progress a special invitation had been extended to the Society by the Bethlehem Iron Company to visit its plant at South Bethlehem, Pa., on Saturday, November 12. This was very generally accepted, even by many out of town members, who otherwise would have returned home promptly at the close of the meeting. Early on Saturday morning the members gathered at the Pennsylvania depot, in Jersey City, and took special cars attached to a fast train, which ran over the Lehigh Valley route. On reaching the works the cars were switched into the company's yard and here the members, who had been accompanied down by H. F. J. Porter, of the company, were transferred to an observation train. This was run over the yard tracks into the various shops of the immense works. The forge was first visited, where the powerful hydraulic presses were shown in operation working heavy engine forgings. After this an open-hearth furnace was tapped and the ladle run to the Whitworth fluid compressing plant, in which the well known system of cooling an ingot under hydraulic pressure was exhibited. Then the heavy forge and the armor plate plant were both shown in operation. In this building there stood an imposing monument to the advances in metallurgical processes and to the enterprise of the company, in the monstrous Nasmyth hammer. Dismantled, and with the anvil block removed, it was very impressive, even in a works so filled with the grandest demonstrations of modern science. Hardening of armor plate was next on the programme, and then another spectacle was witnessed in the silent withdrawal of a great gun jacket from a vertical gas furnace and its rapid disappearanace in an adjacent tank of oil with an accompanying flash of flame. There was so much to be seen that only brief stops could be made and so the members hurried through the assemblage of heavy machine tools for finishing

armor plate, and also the main machine shop. Some idea of the extent of this can be had by considering its length—a few feet under a quarter of a mile. Here there was an immense variety of steel work in the various stages of finishing, including crank and line shafts, guns ranging from 4-in. rapid firers to 12-in. breech loaders with their carriages, and a great variety of steel forgings and castings in as great a diversity of machine tools. After the various steel making departments had been viewed the members were entertained at luncheon in the company's office, and the appreciation of the Society, of the very interesting and instructive visit, was expressed by Member of the Council John C. Kafer, and responded to by R. W. Davenport on behalf of the Bethlehem Iron Company. On the return run it was generally agreed that those members who were unable to take the outing had missed one of the very pleasantest features of the Sixth Annual Meeting.

PAPER ON TOPICAL DISCUSSION.

BY WILLIAM S. ALDRICH, MEMBER.

A very interesting paper was contributed by Mr. Aldrich, who served as a volunteer naval officer during the Spanish war, on the topical question: "As a result of experience on the blockade, what particular points about the machinery were most likely to give trouble, and what could be done to prevent a recurrence of such trouble?"

"I would bespeak a brief consideration of this question from a slightly different standpoint. The work done by the United States repair ship Vulcan, for fifty-four vessels of the regular and auxiliary navy, including all of those of Admiral Sampson's fleet, will of itself form a partial, even if an indirect answer to the question: 'What particular points about the machinery were likely to give trouble?' The Vulcan's part in the war was entirely constructive. Its mission was to make good by thorough repairs or by entirely new parts, those portions of the machinery that actually gave way or were so worn out as to require immediate attention. In addition to this large quantities of engineers' and equipment stores were issued on requisition to the different ships.

"While fitting out at the Boston Navy Yard, the writer was attached to the Vulcan and was later brought into daily contact with the execution of the repair work on the 'shop' deck, during July, August and September, as she lay at anchor in Guantanamo Bay. A detailed account was kept daily of all repair work done, whether executed on board the Vulcan or by her force on board the respective ships, making requisition for such outside work.

"It would extend far beyond the prescribed limits to give even a table of contents of the work done for the steam engineering department of the several vessels, not to speak of that done for the equipment, navigation, ordnance and construction departments of the same. No sooner had the Vulcan come to anchor than she was pressed into requisition for all kinds of repair work. It seemed as though about everything on each and every ship was on the point of giving way or needed repairs. As time wore on such work very naturally arranged itself into characteristic groups. A brief enumeration of these may serve to show 'What particular points about the machinery were likely to give trouble,' whether on blockade duty or occurring in distant waters without access to a navy yard.

"About the main engine, bent piston rods and valve stems, broken packing rings and eccentric rocker arms called for repairs, along with general overhauling, taking leads of cranks and wrist-pins and lining up engine girders.

"Reversing or jacking engines had broken worms, bent shafts, loose and worn collars, keys out of shape and required general tightening up all around.

"Capstan engines presented broken cast iron crossheads, worn wrist-pins and very many broken eccentric straps, and badly worn boxes requiring new ones or re-babbitting old ones.

"Winch engines required the same line of repairs as capstan engines, especially in worn boxes and broken eccentric straps.

"Crane engines required new boxes, new worm wheels, new shafts, new keys and much general overhauling. The cast worm wheels were particularly weak and where not broken in two parts, came up for repairs with several teeth missing.

"Blower engines had broken cylinder heads and required new pistons and packing rings and overhauling of slipper slide.

"Steering engines required chiefly a general overhauling.

"Dynamo engines presented broken mild cast-steel crossheads, broken eccentric straps and rods, where cast in one piece, bent and broken valve stems, broken cylinder heads, worn piston valves and loose wrist pins. One governor wheel required to be rebushed.

"Dynamos were tested for grounds and broken circuits in fields and armatures, and one commutator was trued up.

"Electric motors attached to the small blowers were overhauled and the armatures of two of them rewound.

"Ice machines required new valve stems, slide valve and crosshead.

"Steam pumps called for most numerous repairs to the valve motion, many of the duplex type required rebushing throughout. Broken slide valves and supplementary valves were replaced by new ones. The water ends evidently gave the most trouble and required most general overhauling, chiefly in the soft packing and water pistons. The small duplex pumps of steam launches were continually getting out of order. A common fault with steam launches was the fine waste in the feed checks.

"Steam boilers required scaling, new baffle plates, new grate bars, new internal feed systems, new tubes and expanding and rolling old ones; replacing of badly corroded connections on account of not using zincs properly, repairs to blow valves on account of deranged or broken parts, new tube stoppers, manhole dogs and bolts; calking, particularly of bottom seams; and jacking up of furnaces, down in the corrugation or flat (cylindrical) surface or both in the same furnace. Launch boiler required new dome and ash pan.

"Many cases of badly corroded copper-pipe came up for repairs. In other cases leaks had developed around the soldered and brazed joints and connections where the same had been subjected to mechanical strains which, of course, is an ever recurring trouble in marine work. Very few leaks had occurred in the body of copper pipes due to bad brazing originally or internal pitting or to thin metal. In the case of unbrazed flanged connections the joint was made tight again by refitting the end of the pipe and planing anew into recess in flange.

"Globe and gate valves and plug cocks required reseating, new valves, new top and stems, new plugs. In many cases old valves were entirely replaced by new valves taken from engineers' stores or made from patterns and castings finished in the machine shop. Air pump valve seats, studs and nuts were in demand.

"Steam and water piping required many changes on some of the regular, as well as several of the auxiliary vessels to more thoroughly adapt it to the needs of such distributing systems. Steam gauges were standardized. Electrical fittings were altered for more convenient distribution. Many manufacturing orders were executed for spare parts, such as air pump valve seats, ash hoists, castings, plug cocks, wrist pins of small engines, special studs and screws, special spanner and socket wrenches, reducing hose couplings, crank and ring flanges to check valves, valve stems and bushings.

"The above does not include any of the work done on the former Spanish vessels, the Sandoval and Infanta Maria Teresa. Members will no doubt be surprised to find that many unexpected points of weakness developed in the small and numerous elements of the auxiliary machinery of naval vessels and that much that was expected to give trouble gave no trouble at all. As in other branches of steam engineering, the larger the unit the less liability to derangement."

Changes in Plans for U. S. Monitors.

In our issue of October we published a description, with drawings, of the harbor defense monitors Arkansas, Connecticut, Florida and Wyoming, as originally laid out by the Navy Department. For the vessels so described the bids which were received included the following:

Newport News, S. & D. D. Co.....	$860,000
Bath Iron Works, Bath, Me.....	862,000
Lewis Nixon, Elizabethport, N. J...	825,000
Union Iron Works, San Francisco, Cal.....	875,000
Maryland Steel Co., Sparrow's Point, Md.....	876,000
Wolff & Zwicker, Portland, Ore....	937,500
W. & A. Fletcher Co., Hoboken, N. J.....	927,000
Columbian Iron Works, Baltimore, Md.....	1,015,000
John H. Dialogue & Sons, Camden, N. J.....	1,171,000

The successful bidders and boats which were assigned to them were the following:

Newport News S. & D. D. Co.	...Arkansas
Lewis Nixon, Crescent Shipyard.	.Florida
Bath Iron Works	.....Connecticut
Union Iron Works	.....Wyoming

Before any work was commenced, however, the Navy Department decided to make radical changes in the plans of the vessels, so that instead of having one turret each they would have two and the dimensions would be increased considerably all around, giving vessels with:

L. W. L. length	.....260 ft.
Beam extreme	.....57 ft.
Mean draught at normal displacement, about	.....14.5 ft.
Normal displacement, about	.....4,000 tons
Total coal capacity	..... 400 tons

The changes would include substitution of two turrets for one, as noted, with an increase in armament giving four 10-in. breech-loading rifles, four 4-in. rapid-fire rifles and seven smaller guns in the secondary battery. The revised plans also provide, of course, for larger storage spaces, and for power sufficient to maintain a sea speed of 12 knots on two hours' trial. The increased machinery dimensions include twin-screw engines of 3,200 indicated horse power, with cylinders 18 in., 33 in. and 46 in. dia., by 24 in. stroke, designed for 200 revolutions at 200 lbs. initial pressure.

It was believed by the Navy authorities that vessels of the amended design could be kept within the limits of the original Congressional appropriation of $1,500,000 for each vessel and so the original awards could stand. The contractors have to be heard from in this connection, and at this time the matter is under discussion.

The annual meeting of the American Society of Mechanical Engineers will take place at the Society's headquarters in New York, November 29 to December 2, inclusive. An extensive programme of scientific and technical papers has been arranged, and the meeting promises to be fully up to the usual standard of this Society.

EDUCATIONAL DEPARTMENT.

CALCULATIONS FOR ENGINEERS—AN AID TO CANDIDATES FOR MARINE PAPERS—III.

BY DR. WILLIAM FREDERICK DURAND.

§ 6. RATIO AND PROPORTION.

[2] Compound Proportion.

In many cases the result depends on more than one changing condition. In such case the problem is treated by the method of compound proportion as illustrated in the following example.

When coal is $4.20 per ton the fuel bill for a ship requiring 34 tons per day on a voyage of 2,100 miles is $1,020. At the same speed what would be the bill on a 2,800-mile voyage, with coal at $3.60 per ton, and a consumption of 40 tons a day?

The resulting cost evidently depends on three conditions, and the proportion is stated as follows:

$$\begin{array}{rrcl} & & 3.60 & : \quad 4.20 \\ \text{Ans.} : 1020 :: & 40 & : & 34 \\ & 2800 & : & 2100 \end{array}$$

This consists really of three simple direct proportions each stated exactly according to the rules already given as may be readily seen. For the solution of such a proportion the same rules may be used, but the "product of the means" or the "product of the extremes" must here be understood to mean the product of all the separate numbers forming these terms.

Thus for the foregoing proportion we multiply together the means and divide by the extremes, giving as follows:

$$\text{Ans.} = \frac{3.60 \times 40 \times 2800 \times 1020}{4.20 \times 34 \times 2100} = \$1371.43.$$

Cancellation can usually be made to assist in the reduction of such expressions, and we thus readily find the answer as stated.

Where the relations are such that the answer is inversely proportional to certain of the varying conditions, the ratio involving these conditions must, of course, be so stated as to make this part of the proportion inverse instead of direct. In fact, each of the ratios in the second part of the proportion should be carefully examined in order to make sure whether it should be stated *direct* or *inverse*.

Example involving both direct and inverse proportion:

When coal is $4.00 per ton, the fuel bill for steaming a certain distance at a speed of 12 knots, with a ship requiring 48 tons per day, is $1,800. For the same distance, what would be the bill if the ship requires 40 tons per day, with coal at $3.20 per ton and a speed of 10 knots?

The statement would be as follows:

$$\begin{array}{rrcll} & & 3.20 & : 4.00 & \text{(direct)} \\ \text{Ans.} : 1800 :: & 12 & : & 10 & \text{(inverse)} \\ & 40 & : & 48 & \text{(direct)} \end{array}$$

In this case we have:

$$\text{Ans.} = \frac{1800 \times 3.20 \times 12 \times 40}{4.00 \times 10 \times 48} = \$1440.$$

Problems in Proportion.

(1) An engine with 34 lbs. mean effective pressure gives 1,400 I.H.P. All other conditions remaining the same, what would the engine give with 39 lbs. mean effective pressure?

Ans. 1,606 I.H.P.

(2) An engine making 98 revolutions per mt. gives 1,800 I.H.P. All other conditions remaining the same,

what would the engine give if the revolutions were 90?

Ans. 1,653 I.H.P.

(3) An engine with stroke of 3 ft. gives 900 I.H.P. All other conditions remaining the same, what would be the power with stroke of 42 in.?

Ans. 1,050 I.H.P.

(4) An engine cylinder whose area is 1,200 sq. in. gives 800 I.H.P. All other conditions remaining the same, what would be the power with an area of 1,000 sq. in.?

Ans. 666.67 I.H.P.

(5) A given engine has mean effective pressure 33. revolutions 120, stroke 42 in., and gives 1,800 I.H.P. Other conditions remaining the same, what would be the power with a mean effective pressure of 38, revolutions of 100 and stroke of 4 ft.?

Ans. 1,974 I.H.P.

(6) A boiler with tubes 7 ft. long, and 2 3-4 in. diam. has 2,168 sq. ft. of tube heating surface. What would be the surface, with the same number of tubes, 7 ft. 6 in. long and 2 1-2 in. diam.?

Ans. 2,112 sq. ft.

(7) An engine with 34 lbs. mean effective pressure and 98 revolutions develops a certain power. If the mean effective pressure were 38 lbs., what revolutions would give the same power?

Ans. 87.7 rev.

(8) A given engine has a mean effective pressure 33, revolutions 120, stroke 42 in., and develops a certain power. With mean effective pressure of 38 and stroke of 3 ft., what would be the revolutions for the same power?

Ans. 121.6 rev.

(9) A pump making 40 double strokes per mt. can empty a tank in 1½ hrs. In what time could the same pump, making 30 double strokes per mt., empty a second tank, 20 per cent larger than the first?

Ans. 2.4 hours.

(10) A propeller at 100 revolutions and 20 per cent slip gives a speed of 18 knots. What will be the speed at 120 revolutions and 25 per cent slip?

Ans. 20.25 knots.

---

§ 7. EVOLUTION AND INVOLUTION.[5]

[1] EVOLUTION is the operation of raising a number to successive powers, or of multiplying it into itself as a factor a certain number of times. The number of times the number is used as a factor is called the *index* of the power, and is indicated by a small figure written to the right and above as follows:

$$4^2 = 4 \times 4 = 16$$
$$5^3 = 5 \times 5 \times 5 = 125$$
$$3^5 = 3 \times 3 \times 3 \times 3 \times 3 = 243$$

Evolution involves, therefore, simply continued multiplication. The powers most commonly used by the engineer are the second and third, or *square* and *cube*, as they are commonly called.

[2] INVOLUTION is the inverse of evolution, and consists in finding a number which, used on itself as a factor a certain number of times, will produce a *given* number. The former is then called the root of the latter. The number of times the root is used as a factor is called the *index*, and is represented either by writing this number at the upper left hand angle of the sign of involution, $\sqrt{\ }$, or by the use of a fractional index, written as in evolution. The roots most commonly used by the engineer are the *square* and *cube* roots, corresponding to the second and third or square and cube powers. When square root is indicated by the symbol $\sqrt{\ }$, it is customary to omit the 2 from the upper angle. Thus we have:

$$\sqrt[3]{27} \text{ or } 27^{\frac{1}{3}} = 3 \text{ because } 3 \times 3 \times 3 = 27.$$

$$\sqrt{49} \text{ or } 49^{\frac{1}{2}} = 7 \text{ because } 7 \times 7 = 49.$$

Occasionally the engineer has to deal with the index $\frac{2}{3}$, which is simply a short way of indicating two operations. (1) Raising to the square. (2) Extracting the cube root. Thus $64^{\frac{2}{3}}$ means the 3d root of the 2d power of 64, or the 2d power of the 3d root of 64. Either order of operation will give the same result. Thus:

$$64^{\frac{2}{3}} = \sqrt[3]{64 \times 64} = \sqrt[3]{4096} = 16$$

$$\text{or } 64^{\frac{2}{3}} = \left(\sqrt[3]{64}\right)^2 = 4^2 = 16$$

---

[3] To Extract the Square Root.

This is best illstrated by an *example.* Find the square root of 746.2.

(1)	(2)
0	7·46.20 (27.316 +
2	4
-	
2	346
2	329
40	1720
7	1629
47	9120
7	5461
540	363900
3	
543	
3	
5460	
1	
5461	
1	
54620	

Rule[6]—(1) Point off the given number into periods of two figures each, beginning at the right or at the decimal point, if there is one, and in the latter case point both ways, adding ciphers on the right of the decimal as may be necessary to complete the periods. Thus:

Number	*Pointed Off.*
2643	26·43
867	8·67
424.362	4·24.36·20
.024	.02·40
.6	.60

(2) Write a 0 on the left, thus heading two columns (1) and (2), as shown. Find by trial the greatest number [2] which when squared is equal to or less than the left hand period. Put this on the right as the first figure of the root.

(3) Place this figure [2] under the 0 in col. (1) and add. Multiply the sum [2] by the root figure [2], and place the product [4] under the left hand period in col. (2). This product will be, of course, the square of the root figure. Subtract and bring down the next period for a partial dividend [346].

(4) Again place the root figure [2] on the left and add [4]. Annex a 0 and the result [40] will be a trial divisor for the next root figure.

(5) Divide and take on trial the resulting whole number for the next root figure [7].

(6) Bring down this figure [7] in col. (1) under the 0. Add and multiply the sum [47] by the same root

5. Hand books with convenient tables of powers and roots are so common at the present day that the engineer has small use for the actual operations of raising to powers or of extracting roots. In practice the use of such tables is always counseled as tending toward accuracy, and speed. The importance of these operations, however, merits a brief outline of the process as given herewith.

6 The brackets [ ] contain the numbers in the example which correspond to the special indication of the rule, and thus make its application to the given case more easily followed.

figure [7] and place the product [329] in col. (2) under the partial dividend. Subtract and bring down as before for a new partial dividend [1720].

(7) Place the root figure [7] again in col. (1), add and annex a cipher for a new trial divisor [540].

(8) Find another root figure as before and proceed in this manner till as many figures are obtained as are desired.

If the product found, as in (6), is greater than the partial dividend, it indicates that the trial figure was too great, and the next lower must be taken. If at any time the trial divisor is greater than the partial dividend, enter a 0 in the root, bring down the next period in col. (2) for a new partial dividend, annex a 0 on the right in col. (1) for a new trial divisor and proceed as before.

[4] To Extract the Cube Root.

This is best illustrated by an example. Find the cube root of 12.593.

(1)		(2)	(3)
0		0	12 593 (23.26
2		4	8
2		4	4593
2		8	4167
4	66	1200	426000
2	3	189	320168
60	690	1389	10583200
3	2	198	
63	692	158700	
3	2	1384	
	694	160084	
	2	1388	
	6960	161472 0	

Rule[7]—Point off the given number into periods of three figures each, beginning at the right or at the decimal point, if there is one, and in the latter case point both ways, adding ciphers on the right of the decimal as may be necessary to complete the periods. Thus:

Number	*Pointed Off.*
1724	1·724
17243	17·243
17.24	17.240
.64	.640
.0032.....	.003·200

(2) Write ciphers on the left thus, heading the columns (1), (2) and (3) as shown. Find by trial the greatest number [2] which when cubed is equal to or less than the left hand period. Put this on the right as the first figure of the root.

(3) Place this figure under the 0 in col. (1), add, multiply sum [2] by root figure [2], place product [4] in col. (2), add, multiply sum [4] by root figure [2] again, and place product [8] in col. (3) under left hand period. This product will be, of course, the cube of the root figure. Subtract and bring down the next period for a partial dividend [4593].

(4) Again place the root figure [2] in col. (1), add, multiply sum [4] by root figure, put the product [8] in col. (2), and add [12].

(5) Again place root figure [2] in col. (1) and add as before [6].

(6) Annex one 0 to the result in col. (1) [60] and two 0s to that in col. (2) [1200]. The latter is then a trial divisor for the next root figure, which is thus seen to be probably 3.

(7) The same process of bringing down, adding and multiplying in cols. (1), (2) and (3) is then repeated as just described, and as shown in the example. Continue in this way until as many figures of the root are found as are desired.

If the final product to be entered in col. (3) is greater than the partial dividend, it indicates that the trial figure was too great, and the next lower must be taken. If at any time the trial divisor is greater than the partial dividend, enter a 0 in the root, bring down the next period in col. (3) for a new partial dividend, annex one 0 in col. (1) and two 0s in col. (2) for a new trial divisor, and proceed as before.

It will be noted that in these methods for square and cube root the former requires for each root figure two operations in col. (1) and one in col. (2), while the latter similarly requires three operations in col. (1), two in col. (2) and one in col. (3). Care should be taken that none of these are omitted, and that the entire process is carried through with regularity and order.

[7] The brackets [ ] contain the numbers in the example which correspond to the special indication of the rule, and thus make its application to the given case more easily followed.

§ 8. MATHEMATICAL SIGNS, SYMBOLS AND OPERATIONS.

[1] Mathematical signs are simply shorthand methods of indicating mathematical language. Those most commonly met with are the following:

\+ The sign of addition called *plus*. This means that the two numbers or quantities between which it is placed are to be added. Thus 12 + 3 is read 12 plus 3 and means that 12 and 3 are to be added, the result being 15.

— The sign of subtraction called *minus*. This means that the number or quantity which follows the sign is to be subtracted from that which precedes it. Thus 12 — 3 is read 12 minus 3 and means that 3 is to be taken from 12, the result being 9.

× The sign of multiplication. This means that the two numbers or quantities between which it is placed are to be multiplied together. Thus 12 × 3 is read 12 times 3 or 12 multiplied by 3, the result being 36.

÷ The sign of division. This means that the number or quantity which precedes the sign is to be divided by that which follows. Thus 12 ÷ 3 is read 12 divided by 3, the result being 4.

/ A sign of division. A fraction is really a mode of expressing division, and a common way of writing a fraction all in one line is to make use of the oblique line. Thus 12/3 means the same as $\frac{12}{3}$ or 12 ÷ 3 or 4. Frequently the horizontal line — as shown is used, thus: ½, 1—2 all indicate one-half, or 1 divided by 2. The horizontal line used in this connection must not be confused with the *minus* sign, usually the sense is plainly indicated by the connection in which it is used.

. Placed before and in line with the bottom of a number is a decimal point, showing that the number is the numerator of a fraction which has some power of 10 for its denominator; as .1 = $\frac{1}{10}$, .25 = $\frac{25}{100}$, which reduced to its lowest terms is 1-4. See chapter on decimal fractions.

: The sign of ratio. This signifies the ratio or numerical relationship of the two quantities between which it is placed, and is equivalent to a sign of division, since the quotient of the first quantity divided by the second is the measure of the ratio between them. Thus 12 : 3 is read the ratio of 12 to 3 or 12 is to 3. and the real measure of this ratio is 12 ÷ 3 or 4.

: : The sign of proportion or equality of ratios. This sign is placed between two ratios and signifies that they are equal. Thus 12 : 3 : : 20 : 5 is read 12 is to 3 as 20 is to 5, or the ratio of 12 to 3 equals the ratio of 20 to 5. This is seen to be the case since 4 is the measure of each ratio.

= The sign of equality. This signifies that the two quantities separated by the sign are equal in value. Thus 12 ÷ 3 = 4 is read 12 divided by 3 equals 4, and thus states the equality between the two sides of the relationship.

Equation. Two quantities or expressions related by the sign of equality, =, form an equation. Thus

$$4 + 2 = 6$$
$$a = 3$$
$$a + b = c$$

( ), [ ], { }. *Parentheses* or *brackets.* These symbols mean that all numbers or quantities within a parenthesis or pair of brackets are to be sidered as one quantity and thus treated in all numerical operations. Thus 2 (3 + 4) means that 3 + 4 is to be taken as the single quantity 7, and then multiplied by 2. Similarly

$$2\ (3 + 4 - 2) = 10$$
$$3\ [16 - 2\ (3 + 4 - 2)] = 18$$

NOTE: The sign of multiplication, ×, is often omitted between a number and a parenthesis or bracket containing a quantity into which it is to be multiplied, as in the expressions here shown.

In some cases a bar or *vinculum* is drawn over numbers thus to be taken together. Thus $2 \times \overline{3 + 6}$ means 2 multiplied by the quantity 3 + 6, or 2 × 9, or 18. The difference between $2 \times \overline{3 + 6}$ and 2 × 3 + 6 or 12 will be noted. In reducing quantities thus affected by the signs +, —, ×, ÷ and connected by brackets, the difference in significance between the signs +, — and × ÷ must be carefully noted. Thus 2 × 3 + 6 means 2 times 3 added to 6 or 12 and not 2 times (3 + 6) or 18. As a general principle, it may be remembered that the signs + and — effect a separation of the expression into separate terms, while the signs × and ÷ bind together the two quantities between which they stand into a single term.

Examples—These principles are further illustrated by the following:

$$3 \times 16 - 2 \times 3 + 4 - 2 + 4 \times 3 - 1 = 55$$
$$3\ [16 - 2 \times 3 + 4 - 2 + 4 \times 3 - 1] = 69$$
$$3\ [16 - 2\ (3 + 4) - 2 + 4 \quad (3 - 1)] = 24$$
$$3\ [16 - 2\ (3 + 4 - 2) + 4 \quad (3 - 1)] = 26$$

$\sqrt{\ }$ This sign placed over a quantity denotes the extraction of a root. If no number is placed at the upper left angle, it denotes the square root; otherwise a root corresponding to the index thus indicated. Thus $\sqrt{49}$ denotes the square root of 49 or 7, $\sqrt[3]{27}$ denotes the cube root of 27 or 3, $\sqrt[4]{16}$ denotes the fourth root of 16 or 2, etc.

3^2 or 4^3 or a^4. A small number written to the right and above another number or quantity is called an *index* or *exponent*, and signifies that the lower number or quantity is to be used as a factor on itself a number of times equal to the index. Thus:

$$3^2 = 3 \times 3 = 9$$
$$4^3 = 4 \times 4 \times 4 = 64$$
$$a^4 = a \times a \times a \times a$$

′ ″ These signs set to the right and above any figure or figures (superior) signify feet and inches. These signs are much used in dimensioned drawings.

⊥ Signifies *perpendicular to.*

∠ Signifies *angle.*

⌊ Signifies *right angle.*

∴ Signifies *hence* or *therefore.*

∵ Signifies *because.*

π Denotes the ratio between the circumference and diameter of a circle. Its value is usually taken as 3.1416.

□ Square sometimes used in denoting pressures; as 220 lbs. per □″ or per square inch.

% Signifies *per centum* or *per hundred.*

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—XIV.

BY WM. BAXTER, JR.

The skeleton diagrams of switch boards, shown in Figs. 65 and 66 of the last article will greatly facilitate the understanding of the explanations of Figs. 67 and 68, which represent arrangements of boards designed to fulfill the conditions stated as necessary in the discussion of the first named figures. Fig. 67 represents only one of the numerous ways in which a switch board may be arranged to connect a number of generators with a single distributing system, and Fig. 68 is likewise one of the many arrangements that can be used when the generators are required to feed into two independent distributing systems.

In Fig. 67, it will be noticed that there are four bus bars, while in Fig. 65, which is intended to meet the same conditions, there are only three. This additional bar does not in any way affect the general arrangement, and as will be seen presently when its office is explained, it could be dispensed with if we were satisfied to get along without the volt meter *V′* and the ammeter *A M′*.

The bus bar *I* is the equalizing bus, and, as will be noticed, to it are connected the top brushes of the three generators, by the wires *c*. *B B B* are circuit breakers and *S S S* are switches, thus each generator is provided with means for disconnecting it from the board, and also with a protective device that will automatically open the circuit whenever the current becomes dangerously strong. Each machine is provided with a volt meter *V* and an ammeter *Am*, both instruments being arranged to be permanently in the circuit. By means of these, the current strength in each generator is always indicated and also the voltage. The current from each generator coming from the lower brush passes by the wire *a*, first through the ammeter, and then through the circuit breaker *B* and then through the switch *S*, finally reaching bus *3*. *D D D D D* are circuit breakers placed in the individual external circuits, and *S′ S′ S′ S′* are switches by means of which these circuits can be connected or disconnected from the board. Supposing the *S′* switches to be closed, the current after reaching bus *3* from the generator will pass through the circuit breakers *D* and the switches *S′* to the external circuits, as indicated at the last right hand switch, the current leading out through the wire *f* and returning through *g*. As will be seen the side of the circuit breaker *D* and the switches *S′* to which wire *g* returns the current, connect with bus *4*, and this connects with bus *2* through the ammeter *Am′*. From the position of this ammeter, it will be seen that all the current that passes from bus *3* through the external circuit to bus *4* must pass through it to bus *2* in order to get back to the generators, for bus *4* is not connected with any other part of the system. Such being the case, ammeter *A′ M* measures the whole current developed by all the machines. The volt meter *V′* is connected with buses *3* and *4*, and as the latter is the last point the current reaches before passing to the external circuit, and the former is the first point reached upon the return, it follows that this volt meter registers the actual voltage of the current as it leaves the switch board. From this it will be understood that bus *4* is required simply because *V′* and *A′ m* are used, if they were discarded bus *4* could also be discarded, as then the right hand side of the circuit breakers *D D* could be connected with bus *3* as shown and the other side with bus *2*, from which the current passes direct to the generators through wires *b*. The volt meters *V* are connected to each individual generator circuit at the points *e* and *d*. These volt meters are not indispensible, and when it is desired to practise economy, one instrument may be made to serve for all the

generators, by simply running wires *e* and *d* to it from each generator circuit and providing a small switch by means of which the instrument can be connected with any one pair of wires. These volt meters are very important in starting up a generator, therefore at least one must be used, but as it is not specially advantageous to have them in circuit all the time, in the majority of cases only one volt meter is used for any number of generators, with a switch as above explained for connecting it with any desired machine. The field rheostats are placed at the bottom of the board, as shown at *R R R*, the rheostat proper being back of the board, the only part appearing upon the surface being the hand wheel *w*, by means of which it is manipulated.

The switch board shown in Fig. 67 is only adapted to cases where there is one distribution system; when there are more than one an arrangement such as shown in Fig. 8 must be used. In this diagram the volt meters and ammeters, as well as the circuit breakers and switches belonging to the external circuits have been omitted for the sake of simplicity, but from the explanations given in connection with Fig. 67, the manner in which they should be connected will be readily understood. In this last arrangement it will be noticed that the generators do not connect directly with the bus bars, but, instead, with the center row of connections of the switches *S S S*. The right hand terminals of these switches connect with the upper set of buses and the left hand set with the lower buses. The circuit breakers in the individual generator circuits are shown at *B B B*. As in Fig. 67, the regulating rheostats are located at the bottom of the board, as shown at *R R R*. With the switches in the position shown in the diagram, the handles *L* connect the center contacts with the *s* set on the right hand side, and if we trace the circuit thus formed we will find that starting from any generator by way of wire *a* we reach the lower contacts of the switch, which connect with the bus bar *3*. The opposite wire from the generator, wire *b*, runs to the top contacts and thence to bus *2*, while the equalizing wire *c* runs to bus *1*. If the switch lever *L* is thrown to the left, the generator will be connected with the lower set of buses. From this it can be seen that any one of the generators can be

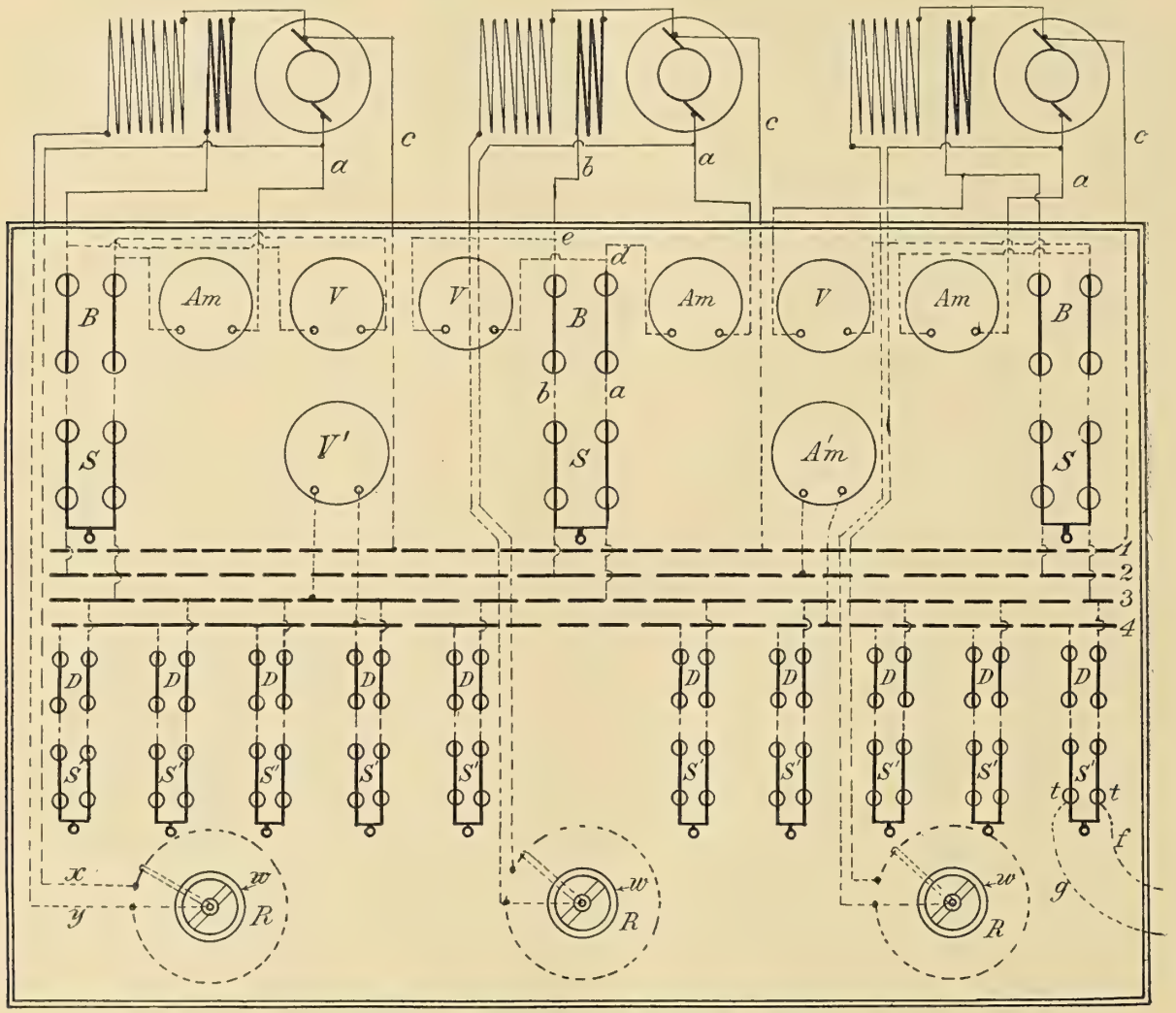


DIAGRAM OF DYNAMOS AND SWITCHBOARD. FIG. 67.

connected with either set of buses. If it is desired to operate the whole as one system, it can be done by throwing the lever of the switch *S'*, which will then connect the two sets of buses.

If it is desired to connect the external circuits permanently with one or the other set of bus bars, switches and circuit breakers such as shown at *D D* and *S' S'* in Fig. 67 can be used, but ordinarily it would be preferable to have them so arranged that they may be transferred from one system to the

other. When such an arrangement is desired, the switch must be of the same construction as the *S* switches of Fig. 68, the external line terminals being connected with the central contacts, and the bus bars with the side contacts. The external circuits, however, only have to connect with the *2* and *3* bus bars, therefore the switches for this purpose will only require two contacts in a row, instead of three. In order that only one circuit breaker may be required for each circuit it is necessary to place the switch between it and the bus bars, just as the main switches *S* are placed between the circuit breakers *B* and the bus bars. In Fig. 68 it will be noticed that there is an equalizing bus bar (1) in each set, and that the switches are made so as to disconnect this

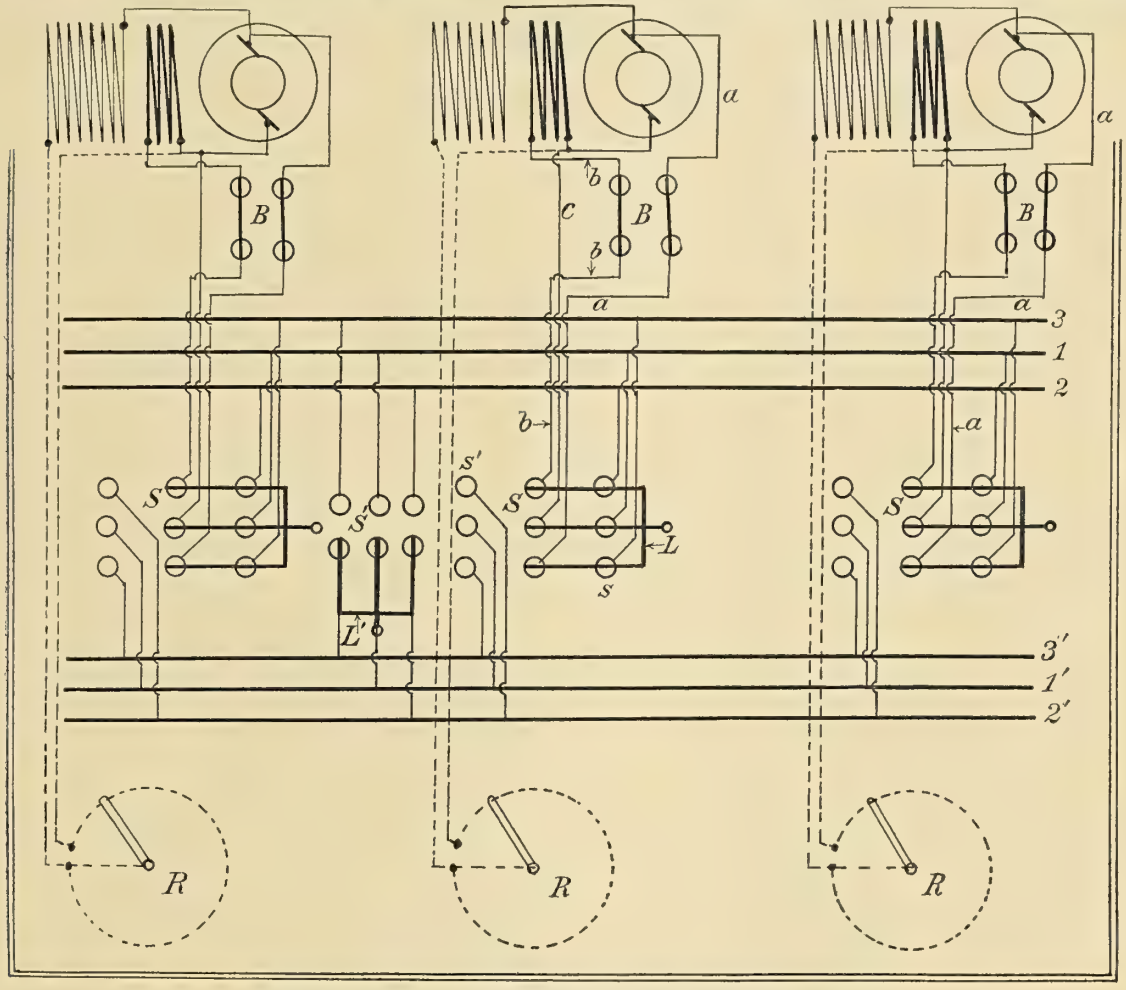


DIAGRAM OF DYNAMOS AND SWITCHBOARD.—FIG. 68.

as well as the main line wires. Considering the part that the equalizing bus plays it might occur to some that this is a needless complication, and that one such bar with switches, that would only change the connections of buses *2* and *3*, would be sufficient. In some cases such an arrangement would meet all the requirements, but with only one equalizing bar the generators when transferred from one system to the other would not be entirely disconnected; therefore, in cases where it is desirable or necessary to operate each set entirely disconnected from the other there must be an equalizing bus in each system. The American line steamship St. Paul, which is arranged with independent external systems that are independent, is operated with a single equalizing bus, and has other simplifications which will be readily understood from the description that will be given in the next article.

ENGINEERS' DICTIONARY.—XII.

Crank.—In general a member of a machine having rotary motion and joined by means of a *connecting rod* to a part having straight line motion. In the marine engine the crank receives its motion from the lower end of the connecting rod and transmits it to the line shaft and thence to the propeller. Fig. 43 shows a three throw built-up crank-shaft or a crank-shaft with three cranks of which each consists of a *crank-pin*, two *crank webs* or *slabs* and the connecting portions of shafting. For many years crank-shafts in mercantile practice have commonly been of the *built-up* variety. In a built-up crank-shaft the parts are made separately and are secured by shrinking the webs on the pins and pieces of shafting, and fastening by keys. In more recent practice to an increasing extent crank-shafts are made of forged steel either in one continuous forging or in sections secured by couplings, one section to each crank. In the higher grades of practice the pins and pieces of shafting are also frequently made hollow in order to save weight, and to give an opportunity to inspect the inner surface of metal and thus detect flaws which might escape an inspection of the outer surface alone Fig. 44 shows a crank-shaft of a destroyer forged hollow in one piece (including the eccentric sheaves) of nickel steel.

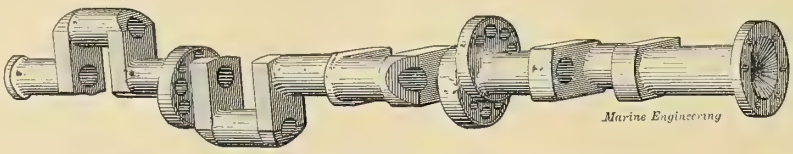
Crank-Shaft.—The name given in a marine engine to the collection of cranks and intermediate connecting pieces of shafting. See *crank*.

Crank-Pit.—The space below the bed-plate of a marine engine directly underneath the crank, sometimes

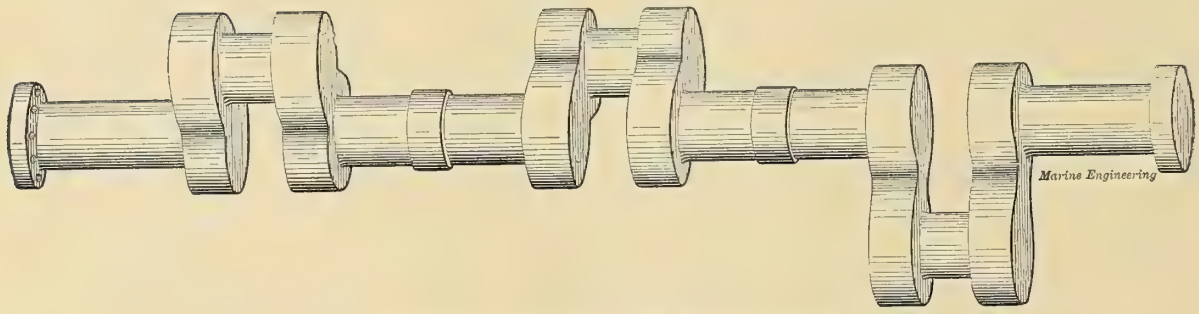
hollowed out specially to provide the necessary amount of clearance.

Damper.—A plate of thin sheet metal in the funnel or the uptake, and so hung that it may be turned more or less completely across the passage of the waste gases, thus checking the draft and decreasing the rate of combustion. When each boiler has a damper in its own uptake, the fires can be cleaned and the tubes swept without interfering with the draft of the other boilers.

Dash-Plate or *Scattering Plate.*—A plate fitted in a jet condenser just under the water discharge, usually pierced with many small holes, and intended to scatter the water in the form of a spray and thus lead to a more ready and intimate mingling of the water and vapor. A plate for the somewhat similar purpose of



HOLLOW FORGED CRANK SHAFT IN ONE PIECE.—FIG. 44.



THREE THROW BUILT-UP CRANK SHAFT.—FIG. 43.

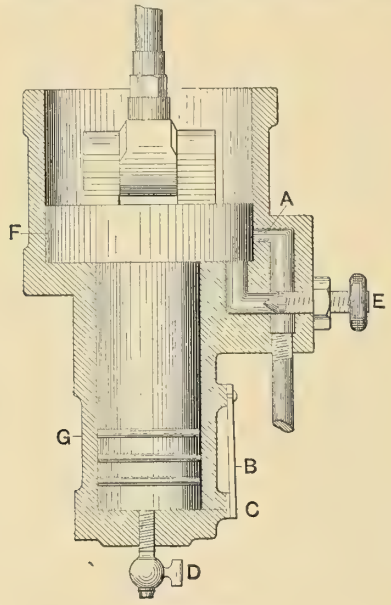


FIG. 45.

distributing the vapor in a surface condenser is sometimes known by the same term. See also *Diaphragm Plate.*

Dash Pot.—A device as shown in Fig. 45 for controlling or checking the sudden motion of a moving piece and bringing it gently to rest. It is largely used on "disengaging" valve gears; that is, valve gears in which at the point of cut-off the valve is released by the valve mechanism and allowed to drop by gravity or drawn quickly by spring or vacuum toward the closed position. This sudden motion is then arrested by the dash-pot and the valve is brought gently to its position of temporary rest. All such devices act by cushioning a piston upon air or by allowing a small amount of leakage of air or liquid past a piston or plunger, according to the circumstances of the motion to be controlled. In the dash-pot pure and simple, the object is to control rapid fluctuations of motion as here noted. When fitted with disengaging valve gear, however, the same device usually contains a second piston or plunger underneath which a vacuum is formed for giving to the valve the quick initial start. In the figure the upper piston cushions on the air which is shut in by its passage across the port A, while the vacuum is formed beneath the plunger G. The leakage is controlled by the valve E. The recoil cylinders on modern gun mounts are a special form of oil dash-pot.

Dead Plate.—In firing with bituminous or semi-bituminous coal it is often the custom to first charge the coal on the front of the furnace and allow it to remain there until the volatile elements are distilled away by the heat and burnt as gas, after which the coal is shoved back over the fire, where the residue burns as carbon. Where furnaces are specially arranged for this mode of firing, the grate bars do not extend to the door or front of the furnace, but instead there is left a space of 15 or 18 inches occupied by a plate upon which the fresh coal is placed. This is known as the *dead-plate.* Even where there is no especial provision for burning bituminous coal, the same name is often given to the plate on which the front ends of the grate-bars rest.

Dead-Centers or *Dead-Points.*—The two points in a revolution when the center lines of the connecting-rod and of the crank-arm are in the same line, and in consequence when there is no tendency from the piston to turn the crank arm in either direction. With the ordinary engine this takes place when the piston is at its extreme travel at one end or the other.

Delivery, *Cock, Valve, Pipe, etc.*—Any cock, valve or pipe, through or by means of which a delivery of something (usually a liquid, vapor or gas) is effected.

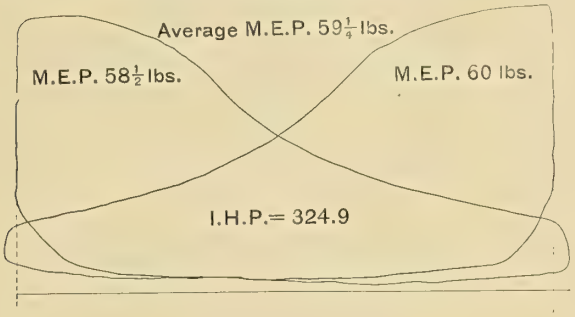
Diaphragm Plate or *Division Plate.*—A plate in a surface condenser for distributing the steam more uniformly throughout the internal volume (See Fig. 32). Plates or partial partitions in certain forms of separators are also known under the same name.

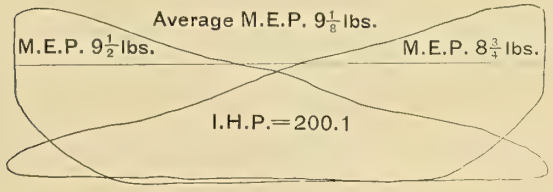
QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Please figure out horse power of cards, and also I would like to hear any criticism. ENGINEER.

A.—The data you send is incomplete. To get the horse power exact it would be necessary to work up the power at each end of the cylinder, as the bottom of the piston is reduced in area by an amount equal to the sectional area of the piston rod. In this case the cards do not indicate the bottom or top end, nor is the diameter of the piston rod given, so we have taken the average of the mean effective pressure at both ends. In most cases the figures thus deduced are very close





to the exact figures. The high pressure card was carelessly taken, for both ends do not come exactly above each other, as shown by the dotted lines. The valve could stand a little more lead, also a reduction in exhaust lap to allow an earlier release, which would give a more even exhaust line. The admission line is very near boiler pressure, but the cut off is bad, as the pressure drops 25 lbs. to the point of cut off. This, no doubt, is due to lack of port opening. The low-pressure card is fairly good, but would be improved by a little more lead. The distribution of power in the engine is very bad, the high pressure cylinder developing over 50 per cent more power than the low pressure, showing that the engine is not runnnig under economical conditions. The pressure in the low pressure receiver is not stated, but judging from the cards it must be about seven pounds. This is far too low for a compound engine of this size and cut off. If the low pressure cylinder is equipped with an independent linking device, it ought to be linked up so that the receiver pressure rises to about 14 pounds; the high pressure remaining undisturbed. Then the mean effective pressure in the high pressure cylinder will be about 48 pounds and in the low pressure about 12 pounds, and the powers in both cylinders will be equal. The power in the two cylinders would be equal with the low pressure cylinder set as shown, if the cut off in the high pressure cylinder was about 18 in., instead of 13 in.

Q.—Kindly inform me whether wetting down coal to be fed to a boiler is coal-saving, or a saving in any sense? If so, state in what way and with what kind of coal, and if not, why not? A SUBSCRIBER.

A.—The addition of water to coal always means a loss in itself, because the water absorbs heat in becoming vapor, and this heat is carried away with the products of combustion. It is sometimes claimed, because the hydrogen and oxygen in the water may become separated and the hydrogen then burn at a later time, or because the vapor may unite with carbon to form water gas, which burns at a later time, that there is a real gain in heat. This, however, is not so. There is heat absorbed in the separation of the hydrogen and oxygen of the vapor, and when the hydrogen burns or unites again with the oxygen, there is exactly the same amount given out. Similarly heat is absorbed in the formation of water gas, and when it is burned the net result is just what would have resulted from the combustion of the carbon part of it.

In short, you cannot use water for fuel any way you may try, and the heat absorbed in turning the water into vapor will be necessarily lost, with the products of combustion, into the air.

On the other hand, the presence of moisture in the fuel may indirectly react on the character of the combustion, or on the way in which the fires may be worked, so as to make it possible to get more out of the coal than if dry fuel were used. Wetting the coal will also decrease the amount which may be blown unconsumed up the funnel by a lively draft. Wetting the coal is believed by many to influence the caking of bituminous coal as well as the formation of clinker. Also the formation of hydrogen or of water gas may distribute the combustion differently throughout the furnace and combustion chamber, and thus lead to a better absorption of heat than if dry fuel were used.

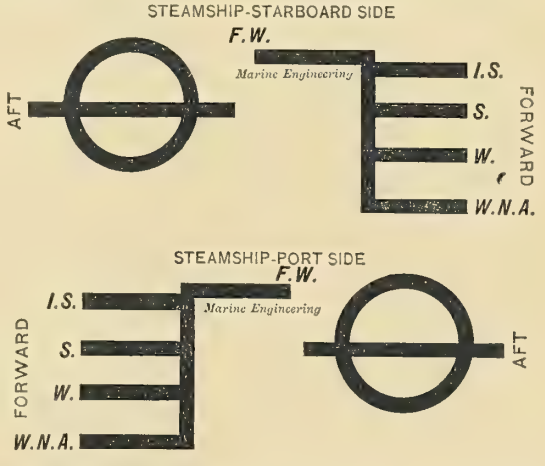
In this way, then, wetting down the fuel may in itself make it possible to get more out of certain grades of coal, may make it possible to better work the fires, or may give a better distribution of combustion and so give a better economical result. The final effect will be therefore the balance of this possible gain and the certain loss first described. In some cases doubtless the net result is a small gain, though, as a general rule, it can hardly be expected that wetting the fuel will result in a net gain of really sensible amount, while, perhaps, more probably the operation may result in a slight loss.

Q.—Please give and explain draught marks noticed particularly on English tramp steamers. E. B.

A.—The marks as they appear on all British steam vessels other than very small coasters, fishing vessels and yachts are shown here in the engravings. The meaning of the initial letters in the scale is:

F W	Fresh water.
I S	Indian summer.
S	Summer.
W	Winter.
W N A	Winter North Atlantic.

The marks are prescribed and applied by the British Board of Trade under authority from Parliament. The location of the



fresh water mark is such that a vessel with load line at F. W. in fresh water will float at S in salt water. The Indian summer mark is used by vessels in trade in the far east at certain seasons of the year. The circular disc is required to show distinctly, and to be 12 in. dia., with a horizontal line 18 in. long through the center.

The marks are located on each side amidships, in white or yellow on a dark ground or in black on a light ground.

RECENT PUBLICATIONS.

THE HEAT EFFICIENCY OF STEAM BOILERS, LAND, MARINE AND LOCOMOTIVE, *with Tests and Experiments of Different Types, Heating Value of Fuels, Analysis of Gases, Evaporation and Suggestions for Testing Boilers.* By Bryan Donkin, M.I.C.E. J. B. Lippincott and Co., Philadelphia, Pa. First Edition, 1898. Size, 7 1-2 by 8 3-4. Pages, 311. With numerous tables, plates and illustrations. Cloth, $8.00.

As might be expected from the author and his subject, this is an exceedingly interesting and valuable work. The getting of the most for the least expenditure has long been the study and aim of man. A slight consideration of the immense sums annually expended for coal, to be burned under the boilers of the world, would convince any one of the value or rather necessity of getting as large a percentage of heat as possible into the form of steam. The subject of heat efficiency becomes, therefore, of great importance. In steamships this is doubly necessary, not only as a question of economy in fuel consumption, but as affecting bunker space which could be profitably utilized for cargo. The author goes right into his subject, omitting all historical and scattering information in regard to boilers. In Chapter I, the different types of boilers are illustrated and their efficiencies noted. The heart of the volume lies in Chapters II and III, which are devoted to summaries of 425 experiments on various boilers. These tables are very full and complete, containing all the data of the tests as well as the calculated efficiencies. Boiler appurtenances, grates, stokers, feed water heaters, etc., receive attention in succeeding chapters. Transmission of heat through plates, smoke and its prevention; suggestions and notes for boiler tests conclude the book. The volume is well printed, and for an English work the illustrations are good. An excellent index of both subject matter and illustrations enhances the value of the book, which unquestionably would be a most valuable addition to the library of every up-to-date practical engineer.

"The Nation's Navy," by Charles Morris, is an excellent compilation for the purpose outlined by the author in his preface. A book for those in whom recent events have awakened a proper desire to know more about American ships of war, and all the modern paraphernalia of destruction which the word Navy embraces. The daily newspaper, or literary periodical refers to battleships and guns, torpedoes and explosives, in a familiar way, while possibly the ordinary intelligent reader knows little of these deadly necessaries beyond the names. To tell him in an interesting non-technical way all about them is the purpose of the author; an ambitious one when to this he adds a concise history of the Navy, and frequent digressions to show the concurrent development in naval circles abroad. In 100 pages the reader is carried along at high speed from the fight at Machias in 1775, through the brilliant deeds of American naval officers in European waters, the fierce fights of 1812, the subsequent battles with sea rovers near home, and the momentous naval engagements of the Civil War, to the beginning of the Spanish war. In the second part the evolution of the iron-clad is traced from Fulton's Demologos, through the inventions of Stevens and Ericsson, to the modern type of ship, and then in succession the American monitor, battleship, cruiser, torpedo boat and submarine vessel are turned inside out for the benefit of the land-dwelling reader. Another division covering armor and armament, powder and projectiles, submarine and land defenses, brings one to the last chapter on "The Navies of the Nations." When all this is crowded into 330 pages the result must be compression, in which many refinements of description are squeezed out; but that is probably just what his reader will admire, and there are lots of admirable features about the book, including the half-tone engravings of well known ships. The author is patriotic, so much so indeed, that at times patriotism collides with accuracy, though the latter is not always on its course. As examples are the statements that "repair ships" and the "interrupted screw" are American inventions, and that the latter is "alone used in the U. S. Navy, and is being adopted abroad." This would be news to Canet and Vickers. Of the other sort are statements that rapid-fire guns "are rarely employed for more than a few minutes at a time, and do not have the opportunity to become heated," and that the Vesuvius "fires projectiles charged with dynamite." Then there is a happy vagueness in the explanation that in the Turbinia "the recently-invented steam turbine is used, in which the impact of steam upon the face of *vans* turns the screw shaft, instead of high pressure being employed as in ordinary engines." These are minor details, however, and only show how excellent are the broader features of the book. It is up-to-date, full of facts, of unqualified interest and in makeup and binding, an artistic production. The publishers are the J. B. Lippincott Co., of Philadelphia. Price, $1.50.

A modern diagram chart for making a ready analysis of the movements of the slide valve is published by the Lunkenheimer Co., of Cincinnati, Ohio. It consists of a card upon which is printed a circle of degrees, and mounted concentrically within this is a movable paper circle with lines indicating the paths of the crank pin and eccentric. At one edge of the card a valve face with ports (its center corresponding with the center of the degree circle) is printed, and a separate card with straight edge extension represents a section of a valve. Other forms of face and valve can be substituted as required, and results in the setting of valves can be reached independent of any purely matematical work.

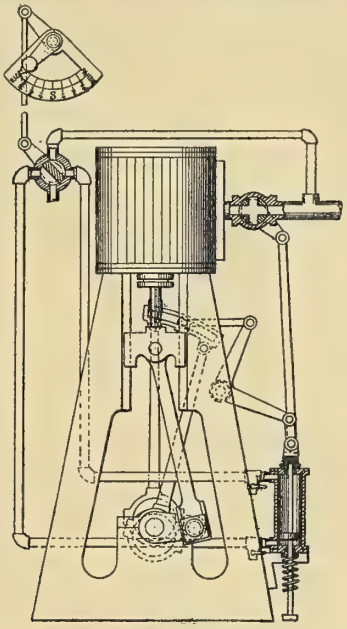
"The Book of the Ocean," by Ernest Ingersoll, is a remarkably clever compilation, combining a whole lot of technical information about ships and the sea, with lively historic narrative; an ideal book for the youth of the country. It contains over 270 pages and not an uninteresting paragraph, and the abundance of illustrations, drawn with artistic spirit, give it an additional attractiveness. To show the breadth of its purpose a glance at the table of contents is instructive: Ocean and its origin; wave tides and currents; building of ships; early voyages and polar explorations; warships and naval battles; sea merchants and pirates; yachting; dangers of the deep; fishing; sea plants and animals. It would be an ideal Christmas gift for a boy who had shown any interest in marine affairs, or, indeed, would induce an interest in the ocean even in a resident of the middle west. The type is bold and the printing in keeping with the reputation of the De Vinne Press. The book is published by The Century Co., New York, price $1.50.

Interest in present naval affairs has been intensified greatly by the recent operations in the Spanish war, and it is but a step back to the previous chapter in U. S. naval history—the Civil War. For the many who want to refresh their memory of the stirring events in the Sixties, or for those who wish to enjoy the story of those days as a first experience, Charles Scribner's Sons, of New York, have provided a handsome and compact set of volumes entitled: "The Navy in the Civil War." It consists of three volumes of about 250 pages each, each complete in itself, and yet forming a section complimentary to the others. The first book treats of "The Blockade and the Cruisers," and is by Prof. Soley, U. S. N.; the second book covers "The Atlantic Coast," by the late Rear Admiral Ammen, U. S. N.; the third book is about "The Gulf and Inland Waters," and is from the pen of Commander Mahan, U. S. N. The volumes are uniform in size and style, and each has an engraved frontispiece and various maps illustrating the text. Separately they are sold at $1.00 each; $3.00 for the entire set.

SELECTED PATENTS.

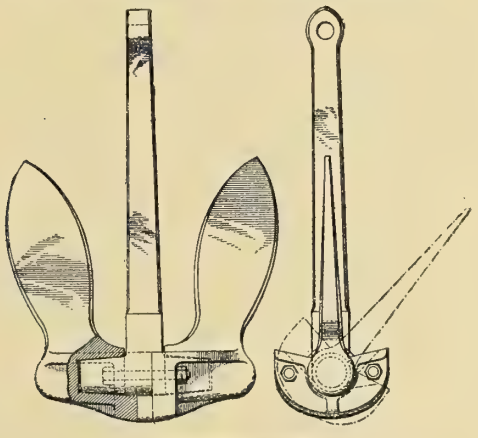
604,253. ENGINE-CONTROLLING DEVICE. *Alexander P. Loper, Stonington, Conn. Filed September 9, 1897.*

In an engine-controlling device the combination with the throttle-valve and the reversing-gear of an auxiliary cylinder containing a piston normally in a middle position in the cylinder the piston being connected with the throttle-valve and the reversing-gear, a valve connected with a fluid-pressure supply and



LOPER ENGINE CONTROLLER.

with the ends of the auxiliary cylinder to admit a fluid under pressure to either end of the cylinder to shift the piston, and means under the control of the operator for shifting the valve and indicating its position. An engine-controlling device, comprising an auxiliary cylinder containing a piston connected with a throttle-valve and with the reversing-gear of the engine, for actuating both simultaneously, a valve



BOWER'S ANCHOR.

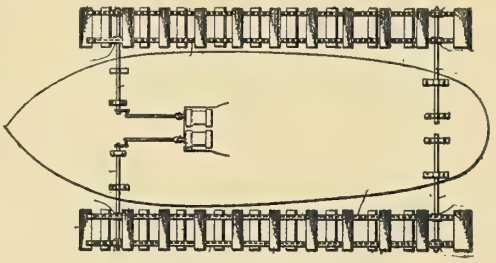
directly under the control of the operator, and connected with a supply and with both ends of the auxiliary cylinder, and springs connected with the piston-rod of the auxiliary cylinder, to hold the piston normally in a middle position. An engine-controlling device, comprising a quadrant having a pointer, a valve having its plug positively connected with the pointer, the valve being connected with a steam-supply and with an exhaust, an auxiliary cylinder connected at its ends with the valve, to permit of sending steam from the valve to either end of the cylinder, a piston contained in the cylinder, and having its piston-rod pressed on by springs, to normally hold the piston in a middle position, and means for connecting the piston-rod of the piston with the throttle-valve of the engine and with the reversing mechanism.

602,719. ANCHOR. *La Mont M. Bowers, Cleveland, Ohio. Filed September 21, 1897.*

In an anchor, the combination with the shank and cross-arm, of a separable fluke-head composed of two duplicate sections, and provided with interlocking lugs at their point of juncture, whereby the sections are locked against torsional strain in relation to each other, and are interchangeable. In an anchor, a shank provided with trunnions, in combination with a jointed or separable fluke-head, the sections of which are secured against pulling apart longitudinally, by bolts, and against torsional or lateral strain in relation to each other, by interlocking lugs. An anchor comprising the usual shank having frusto-conical trunnions on which the fluke portion rocks, in combination with a separable fluke portion, the sections of which are secured together longitudinally by bolts, and held against turning laterally in relation to each other by interlocking lugs.

599,050. CHAIN-PROPELLER. *William S. Winsor, St. Louis, Mo. Filed November 19, 1896.*

A combined ship propulsion and steering mechanism comprising independent shafts journaled in bearings at the front of the vessel and extending out from the sides, a plurality of sprocket-wheels secured to the outwardly-projecting portions of shafts, independent shafts journaled in bearings connected to the vessel at the rear, and likewise extending out from



WINSOR CHAIN PROPELLER.

opposite sides of said vessel, a plurality of sprocket-wheels secured to the shafts in alinement with the sprocket-wheels on the shafts at the front of the vessel, a plurality of sprocket-chains at each side of the vessel which chains run over the sprocket-wheels of the front and rear shafts, inclined blades or paddles connected to all the sprocket-chains at the respective sides of the vessel by angle-irons, and independent engines operatively connected to the shafts at the front of the vessel whereby the propelling mechanisms can be operated simultaneously or independently to propel or steer the vessel.

OBITUARY.

J. Taylor Gause, president of the Harlan & Hollingsworth Co., died at his residence in Wilmington, Del., December 1, from an attack of pneumonia.

John B. Coyle, who was prominently identified with New England coast steamship interests, died at his residence in Portland, Me., November 7, aged 57 years.

J. W. Keely, who claimed to have discovered a new force, and invented a motor to convert it into useful work, died in Philadelphia, November 18. For a number of years he used the motor for the extraction of money from credulous capitalists, apparently finding that its efficiency was greater for this purpose than for any application to industrial uses. He left papers, which, if properly interpreted, ought to make his successor rich.

TRADE PUBLICATIONS.

A neat desk blotter containing a suggestion of mechanical rubber goods is sent to all inquirers by the Boston Belting Co., 256 Devonshire St., Boston, Mass.

A 6 by 9 cardboard containing a picture in colors of the new World feed water heater is sent to all inquirers by the Robertson Mfg. Co., 218 Fulton St., New York.

Valves, planimeters, indicators and gauges are illustrated and briefly mentioned in a small folder issued by the American Steam Gauge Co., 36 Chardon street, Boston, Mass.

A picture is sent free by Captain M. De Puy, 19 South St., New York, showing the boat Paragon towing ten heavily laden canal boats around the point at West Point, N. Y. The picture is 7 by 10 in. in size.

Draughtsmen will find an interesting circular in one issued by Theodore Alteneder, 945 Ridge Ave., Philadelphia, Pa., giving detailed information of the spring-hinge ruling pen; also of the Leader ruling pen.

The Lloyd water-tube boiler being put on the market by W. A. Lloyd, Ashtabula, Ohio, is well described in a 4-page folder just issued. Sectional drawings illustrate the type of boiler and complete the description.

A four page folder neatly printed in red and black describing and illustrating the Eclipse marine reducing valve is ready for distribution by the John Davis Co., 51-79 Michigan St., Chicago, Ill. A full description of the valve is given.

A full line of steam specialties is illustrated and described in a 64-page cloth bound catalogue issued by F. Hennebohle, South Chicago and Erie avenues, South Chicago, Ill. Many of these specialties are especially designed for marine work, and are such that every engineer will want to know of them.

The Stevenson automatic airtight door is thoroughly described and excellently illustrated in a 12-page folder printed on coated paper in two colors. These doors are especially adapted for refrigerating rooms and for any apparatus where fire-proof or smoke-tight doors are desired, and are manufactured by the Stevenson Co., Ltd., Chester, Pa.

Signal lamps of all kinds, as manufactured and sold by Russell & Watson, 145 Main street, Buffalo, N. Y., have much said regarding them in a 10-page folder recently issued. Several styles of lamps manufactured by this company are illustrated and considerable information is given regarding the patent fluted lenses which are the special feature of these lamps. Every marine man should send for a copy of this circular.

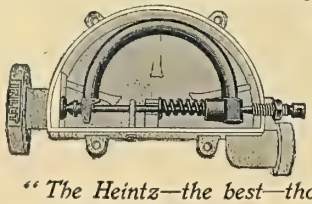
The Montauk multiphase electric cable is fully described in a 32-page book, 7 by 9 in. in size, with heavy cover. On nearly every page is a startling illustration of fire in some form or other, and much information is given showing the application of this cable to steamships and other uses for protection against fire. A copy of this book can be had by sending to the Montauk Multiphase Cable Co., 100 Broadway, New York.

One of the neatest catalogues we have received for some time is received from J. J. Ryan & Co., 68-74 West Monroe St., Chicago, Ill. It contains ten pictures illustrating the works of the company and some of the products. The works are believed to be the largest jobbing brass foundery in the country, if not in the world, and the pictures show that the company is prepared to turn out anything in the line of brass goods, anti-friction metal, bronze, etc. Everybody interested in the subject of brass goods should not fail to have a copy of this exceptionally handsome catalogue.

Labor or Steam

wasted in your plant? Suppose you had a hundred men on your pay roll, and fifteen to thirty doing nothing—"air punchers"—how long before you would weed them out? Yet, that's your proportion of loss in power when you run a plant without the "Heintz" Steam Trap.

Automatic, silent, economical, lasts a lifetime. Only six parts besides the case—can't wear out. No levers, floats, air valves or theories—just plain mechanics. Sent on thirty days' trial on request. Booklet "G" will finish the story. Want it?



William S. Haines Company,
136 South Fourth Street,
Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. B

REDUCING VALVES

to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.

Sturtevant patent steam hot blast apparatus is told about, with very choice illustrations and printing, in a 4 by 9 catalogue just issued. It is a beautiful specimen of typography, and, as the introduction says, "contains the essence of what they believe to be essential to a knowledge of the construction, advantages and patented features of the Sturtevant hot blast apparatus. The apparatus is made by the B. F. Sturtevant Co., Jamaica Plain, Mass.

An exceptionally fine catalogue containing 60 pages, 6 by 9 in. in size, is issued by G. M. Davis & Co., 100 North Clinton St., Chicago, Ill. It is unusually well printed, and there is an engraving on almost every page, the pictures being much above the average in quality. Many of the steam specialties therein described are designed especially for marine work, and many testimonials and much detailed information is given.

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

It will pay you to send for Sample and Pamphlet. No charge.

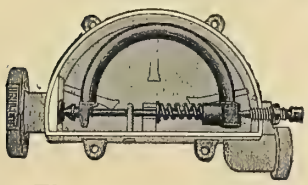
JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

Efficiency

makes the value of the "Heintz" Steam Trap—lots of others where you get more iron for your money—lots of imitations, too—and some of them look almost exactly like the "Heintz."

Every puff of steam you lose means a loss of more or less money-profits gone. Use the "Heintz" on your outlets, wherever steam escapes, and you will have an increased boiler capacity. We have saved some concerns large sums—more than we dare say. Can save you something, too.

The cost? Of little moment when traps are needed. Booklet "G" tells the starting point. Get one from us.



William S. Haines Company,

136 S. 4th St., Phila.

"The Heintz—the best—tho' it has imitators."

©COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 2

Users of injectors and other steam specialties will want to send for a copy of the pocket-size catalogue just issued by the Hancock Inspirator Co., Watson St., Boston, Mass. It contains 32 closely printed and well illustrated pages devoted exclusively to the subject. It is a good business like catalogue.

Portable drills and other special tools manufactured by Thomas H. Dallett & Co., York street and Sedgley avenue, Philadelphia, Pa., are illustrated and described in a 40-page catalogue. Thes etools are particularly adapted to shipbuilders' uses, as they will drill in any direction and among any conditions. Further information can be had from the catalogue.

"Painting on Metal, with Specifications" is the appropriate name selected for a neat pocket book issued by Edward Smith & Co., paint manufacturers, 45 Broadway, New York. It consists of a technical discussion of the subject by A. H. Sabin, M.S., and a supplement containing many useful practical points about paints in general and the manufactures of the publishers in particular. This little book is really a creditable production, very different from the customary trade puff in leather covers. The author is an engineer and chemist of reputation, and he discusses the subject with an apparent knowledge and experience that attract the close attention of the interested reader. He is indeed an apostle of paint. In paragraph and page he reiterates the necessity for proper preparation of metallic surfaces before paint is applied, and goes into detail of the several processes: Sand blast, pickling, and scraping and brushing by hand. The book is profusely illustrated with engravings of various structures from railroad termini to stand pipes, to which the Smith paints have been applied.

BUSINESS NOTES.

PATENT SUSTAINED.—The Federal Circuit Court has handed down a decision in favor of the Hancock Inspirator Co., Watson street, Boston, Mass., regarding the Loftus patent ring valve which is used in many types of injectors.

MARINE ELECTRIC PLANT.—The contract for the electric plant on the new government coast survey steamer Pathfinder has been awarded to the E. G. Bernard Co., Troy, N. Y. This company has done considerable electrical work on government vessels and many well known yachts.

ROSS REGULATOR VALVE.—Attention is called to the cut of the regulator valve shown in the advertisement of the Ross Valve Mfg. Co., Troy, N. Y., in our advertising pages. This valve is especially designed for marine work and full information regarding its many qualities can be had from the company.

A BIG ORDER FOR PUMPS.—The Snow Steam Pump Works, Buffalo, N. Y., have received orders for the pumps to be installed on the vessels which the Cramp Shipbuilding Co. is building for the Russian Government. It is one of the largest orders placed for some time for pumps and is said to aggregate over $50,000.

A LARGE VENTILATING PLANT.—Four large electric fans having a combined capacity of 134,000 cubic ft. of air per minute have recently been set up in connection with the Boston Subway for the purpose of securing the necessary ventilation. They were designed, constructed and installed by the B. F. Sturtevant Co., Boston, Mass.

SHALLOW DRAUGHT STEAMER.—The Marine Iron Works, Clybourn and Southport avenues, Chicago, recently shipped a shallow draught steamer to the International Land & Colonization Co. in Mexico. The steamer is 58 ft. long, 11 ft. beam and draws 8 in. of water. She is designed to carry both freight and passengers. The boat was shipped to Mexico in sections, where she was put up.

A Fine Fishing Boat.—A fine boat has just been received by Captain Balzer, Rockaway Beach, L. I., 45 ft. long and 12 ft. beam, built by the Daimler Mfg. Co., Steinway, L. I., and equipped with Daimler motors. The boat will be used for fishing and pleasure parties.

A Marine Railway For Norway.—H. I. Crandall & Son, the well known firm of marine railway engineers of East Boston, Mass., have received an order from parties in Stavanger, Norway, for complete designs and working drawings for one of their improved marine railways to be built at that port.

Work In Brass, Bronze and Copper.—Many concerns doing work in brass, bronze and copper are in the market for special lines of goods in these metals, and attention is called to the advertisement elsewhere of the Standard Brass Works, Kalamazoo, Mich., which make a specialty of this line of work.

Enlarged Plant.—Owing to the great increase in business, the Norton Emery Wheel Co., Worcester, Mass., has built large additions to its establishment, and erected an 18 ft. kiln. With the new facilities the company will be in shape to fill promptly orders for anything in the line of emery wheels or grinders.

Tools For Navy Yards.—The Navy Department recently contracted for a considerable amount of machinery for the League Island Navy Yard, and awarded many thousand dollars' worth to the Niles Tool Works Co., Hamilton, Ohio. This company is a large builder of special appliances for shipbuilding.

Graphite Bushings.—Bushings and bearings especially where they are difficult to lubricate are offered by the Graphite Lubricating Co., Bound Brook, N. J. They are especially adapted for tackle blocks, steering gear, thrust bearings and in short any kind of a bearing where there is friction. Circulars and full information can be had upon application to the company.

Feed Water Heaters.—The Goubert Mfg. Co., 16 Church St., New York, is among the largest manufacturers in the country of feed water heaters, and during the past few months has installed many thousands of horse power of stationary work, one order alone calling for 35,000 horse power. This company also makes heaters for marine uses. Full information regarding them can be had upon application to the company.

Howden Hot Draft.—The Cleveland Shipbuilding Co., of Cleveland, Ohio, is pushing work on a 6,000 ton steamship which is to have 1,250 horse power. The purpose is to make her one of the most economical carriers on the lakes, and among other special appliances is the Howden hot draft, installed under the supervision of the Dry Dock Engine Works, Detroit, Mich.

Fulton Metallic Packing.—A metallic packing which engineers can carry in stock is the Fulton metallic packing which is backed up by very strong recommendation from Captain Du Bois, who has charge of the Erie Railroad floating equipment. Reference is made to this recommendation in the advertisement of J. L. Robertson & Sons, 218 Fulton street, New York, who are the manufacturers of this patent.

Seamless Drawn Tubing.—In his recent report regarding the U. S. Navy, Commodore George W. Melville stated "seamless drawn steel boiler tubes have been furnished during the year for all classes of our boilers with a degree of excellence undreamed of a few years ago." Practically all tubes of this kind furnished to the Government were supplied by the Shelby Steel Tube Co., Cleveland, Ohio. Much valuable information regarding high-grade tubes can be had by writing to the company.

Saved by the Anchor.—Captain Walter J. Thompson, of the steamer John H. Estill, under date of October 3, wrote as follows to the Baldt Anchor Co., Chester, Pa., from Savannah: "Yesterday we had a hurricane here, and I was anchored in the Savannah river six miles below the city, and used the anchor we ordered from you. The wind was blowing over sixty miles an hour ,and we only used the one anchor with 35 fathoms of chain, and it held us (we anchored in 4 1-2 fathoms of water). Vessels in the river dragged with two anchors and went ashore, while we only used one (the one we ordered from you). I think that speaks for itself. I would not have any other if I could get your make. My vessel is the steam pilot boat John H. Estill.

ENGINE FOR SALE.

An 8 inch, 12-inch, 16-inch and 24-inch by 18-inch stroke quadruple expansion Wells balanced engine for sale; in perfect condition.

FORE RIVER ENGINE CO.
Weymouth, Mass.

ELECTRICITY FOR MARINE ENGINEERS

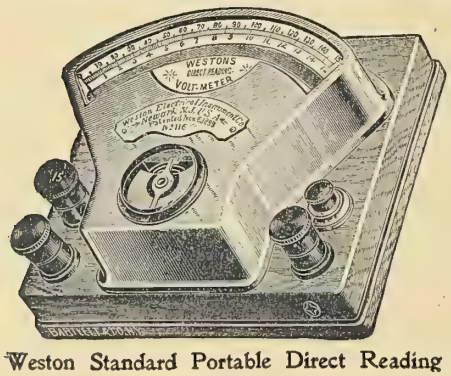
Every intelligent engineer appreciates the fact that a working knowledge of electrical engineering has now become one of the conditions upon which many of the best positions depend.

Our Junior Course in Electrical Engineering meets this want. For our handsome illustrated **Free** book entitled **"Can I Become An Electrical Engineer?"** address

DEPT. S, THE ELECTRICAL ENGINEER INSTITUTE OF CORRESPONDENCE INSTRUCTION

HERMAN A. STRAUSS, E.E., General Manager **120 LIBERTY ST., NEW YORK, U. S. A.**

ENDORSED BY EVERY PROMINENT ELECTRICAL ENGINEER



Weston Standard Portable Direct Reading Voltmeter.

WESTON STANDARD PORTABLE

DIRECT READING

VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Intruments are recognized as **THE STANDARD** the world over. Our **VOLTMETERS** and **AMMETERS** are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.,
114-120 William St., NEWARK, N. J., U. S. A.

ELECTRICAL ENGINEERING.—Engineers desiring to inform themselves on electrical subjects will find a school devoted to this field exclusively in the Electrical Engineers' Institute of Correspondence Instruction, 120 Liberty St., New York. Any man of ordinary education can take the course, and at a moderate cost, payable in instalments.

AN ENGLISH ORDER.—The Newton Machine Tool Works, Philadelphia, Pa., have just received contract from John Brown, of Sheffield, England, who is the largest manufacturer of armor plate in the world, for a Special Double Radial Drilling Machine for drilling armor plate. They are also completing the drawings of a large cold saw cutting-off machine for the Armor Plate Works at Creusot, France. Mr. Charles C. Newton, of this company, has just returned from abroad, where he went on the special invitation of these firms, having in view the securing an order for these machines.

NOVEL MARINE ELECTRIC SET.—The Bullock Electric Mfg. Co., Cincinnati, Ohio, is getting out a new line of small generators, well adapted for small lighting plants for yachts and other craft. They are built either for high speed to be belt-driven or slow speed for direct connection. The company has lately put one of these small generators in the new steam launch for E. H. R. Green, president of the Texas Midland Railroad. This dynamo furnishes about sixty incandescent lights for the cabin and deck and one large search-light forward. The dynamo is operated by two Fairbanks, Morse & Co. gasoline engines, coupled together by means of a shaft. Two small engines were used as one large engine was not light enough, nor sufficiently compact. The dynamo is run by means of a belt from a solid disc fly-wheel between the engines. The dynamo is also fitted with a solid disc cast with pulley.

WHY DID WE, IN OUR LATE UNPLEASANTNESS WITH SPAIN,

deliver to **U. S. NAVY** more "**EUREKA**" **Packing** than all the other **Soft Packings Combined?** They recognize it as the best, and not one of the **War** Vessels went to sea without a full stock in their storeroom. Can you afford to pass it by without trying?

For 2 labels, showing weight, cut from front of **EUREKA** boxes we send a beautiful set of fancy playing cards.

Be sure this label in RED is on the box and every few feet of packing. All others are Imitations.

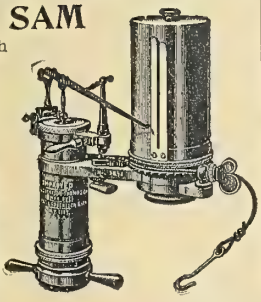
UNCLE SAM

thought enough of our

ROBERTSON THOMPSON INDICATOR

to use a number of them on his war vessels. If you are interested, send for circular and discount.

Price $60.



For HIGH STEAM

can you do any better than this?

Gentlemen:

The **FULTON FLEXIBLE METALLIC PACKING** you furnished us 3 years ago is still in use and has been so satisfactory we have just made requisition for more and will expect the same good quality. Yours truly,

E. DUBOIS,
C. Eng. Floating Equipment, Erie R.R.,

Price $1.25 per lb.

Jas. L. Robertson & Son, 218 FULTON ST., NEW YORK. | Boston Branch 12 PEARL ST.

PROFESSIONAL CARDS.

GARDNER & COX,

NAVAL ARCHITECTS, ENGINEERS AND YACHT BROKERS.

1 BROADWAY, NEW YORK.

WILLIAM GARDNER.
IRVING COX. TELEPHONE CALL, 2007 BROAD.

GUSTAV HILLMAN,

NAVAL ARCHITECT.

Designer of all classes of **Vessels. Steam Yachts a Specialty.**

470 GREENE AVE., NEAR NOSTRAND, BROOKLYN, N. Y.

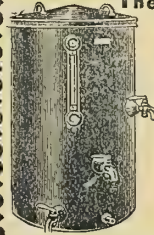
H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.

Manufacturer of **Screw Propellers** for Usual and for Special Work.

The Allen Dense Air Ice Machine for Steam Vessels.

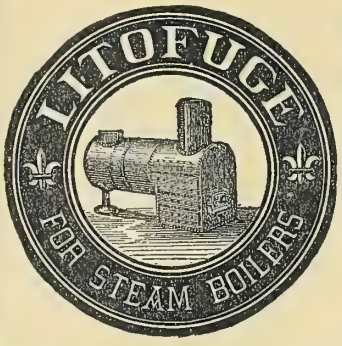
41 MAIDEN LANE, NEW YORK.



The **CROSS OIL FILTER**

actually reduces oil bills 50% or more. Sent on approval. Used in 17 countries. Adapted to steam vessels of every description. Send for circulars, testimonials, etc.

THE BURT MANUFACTURING CO.
AKRON, OHIO, U. S. A.
The Largest Manufacturers of Oil Filters in the World.



Free to Engineers.

Upon receipt of name and address and where employed, a fine English bulldog

BRIAR WOOD PIPE.

There's nothing like LITOFUGE for Marine Boilers.

It won't cost you a cent to try **LITOFUGE** unless it does just what we say it will do. We claim—

That it will clean the dirtiest boiler in 60 to 90 days, without injuring the metals;

That it is the *only* Compound that will *positively* prevent the formation of scale in a new or clean boiler;

That it will prevent corrosion, and stop it where it has already started;

That it does not eat the scale; simply loosens it from the metals.

LITOFUGE acts mechanically (not chemically), contains no soda, soda ash, nor acid. Give us nominal horse power of your boilers and character of water used, and we will send you, freight prepaid, a trial order, to be paid for *only* if satisfactory. Pamphlet for the asking.

LITOFUGE MFG. CO.,

1710-1712 Market Street, PHILADELPHIA, PA.

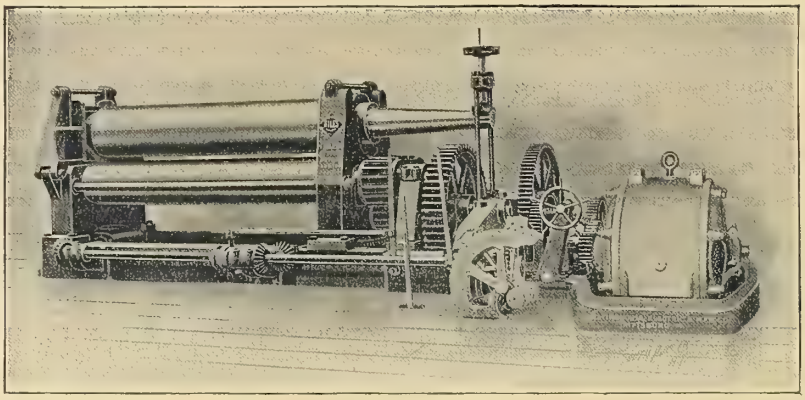
Pumps and Condensers.—We are informed by the Deane Steam Pump Co., Holyoke, Mass., that the business of this company has been unusually good the past year. Orders for marine pumps have been exceptionally large and among the orders which they are now executing for this class of machinery is one for the City of Boston, and comprises air and circulating pumps, boiler feed pumps, boiler circulating pumps, also fire and bilge pumps for double screw ferryboat No. 3. The company is busy on three cylinder pumps and surface condensers; one of the largest sizes listed is to go to Southern Africa. Five of one size were recently shipped to Europe and one was furnished to the state police boat in Boston harbor.

The Dixon Products.—During the past summer the Joseph Dixon Crucible Co., Jersey City, N. J., has added an extension to its pencil factory, 40 by 90 ft., three stories high, where all machinery is driven by electric power. No expense has been spared in the equipment of this addition in the way of up-to-date elevators, furnaces, dry-rooms, etc. The Dixon Company's products go into every known field of industry; iron workers, brass workers, printing trades, stationers, cycle manufacturers, hat manufacturers, etc.

Boats For Steam Yachts.—J. G. Cassatt, of Philadelphia, owner of the ocean-going steam yacht Eugenia now being built at the Roach shipyard, at Chester, Pa., from designs of Gardner & Cox, of New York, has ordered from the Spalding St. Lawrence Boat Co., of Ogdensburg, N. Y., a set of boats to carry at the davits, viz.: a handsome sailing lifeboat, 18 ft. long; one 12 ft. dinghey, and one 18 ft. cutter, all to be of mahogany throughout. This company also has orders for boats for Eugene Tompkin's new yacht, as well as for Richard Stephen's. All the boats will be finished in mahogany and be fine samples of the boat builders' art.

Westinghouse

ELECTRIC POWER as applied to mills and shipyards by the "Westinghouse System," reduces the operating expenses to the minimum, increases the output and introduces many advantages that are impossible with other systems.



40 H.P. Type "C" Motor, Driving Heavy Plate Bending Rolls.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa.,

And all Principal Cities in the U. S.

WESTINGHOUSE ELECTRIC CO., Ltd., 32 Victoria Street, London.

The name of WESTINGHOUSE is a guarantee.

MARINE WATER-TUBE BOILERS.—The Stirling Water Tube Boiler Co., Pullman Building, Chicago, Ill., has perfected arrangements to go extensively into the business of building water-tube boilers designed especially for marine work. In order to supply boilers of any capacity the company has secured the American rights to be exclusive builders of the Niclausse and Yarrow boilers and arrangements have also been perfected to manufacture the Mosher boiler. The company is one of the largest establishments in the United States designed especially to build water-tube boilers, giving it ample facilities to fill any order at short notice.

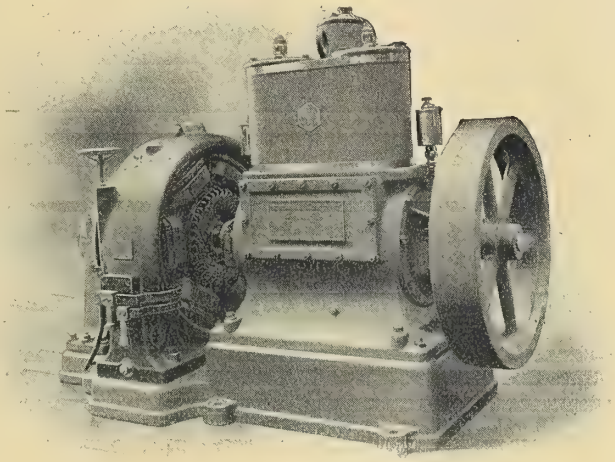
GOOD STEAMING RECORD.—Captain M. De Puy, 19 South street, New York, inventor of the Paragon boiler, has received the following very highly complimentary letter: We, George E. Noyes and Nicholas W. Godfrey, are owners of the new steam canal boat Paragon, purchased from Captain M. De Puy, which has been run by us eighteen days on only thirteen tons of coal. The boiler lies over any marine boiler we have ever owned, seen or heard of. It is actually doing its work on half the fuel burned by our steamer Silex, which is of the same dimensions as the steamer Paragon. Therefore, it is apparent that the Paragon boiler will save to us in fuel bills from $800 to $1,000 annually, or at least $8,000 in ten years." The Paragon recently made a trip down the Hudson river towing ten canal boats fully laden with a small consumption of coal, very astonishing to canal boatmen. Full information regarding this trip and the boiler can be had from Captain De Puy.

MARINE PRESSURE REGULATOR.—The No. 5 pressure regulator for marine service, which is being put on the market by G. M. Davis & Co., 100 North Clinton street, Chicago, Ill., is designed especially for steamship service. It is claimed to reduce from any initial pressure to any working pressure desired and to regulate successfully where a high, true pressure is desired.

Westinghouse

SHIP LIGHTING.

The Westinghouse engine is peculiarly adapted to marine service by reason of the small floor space required and the reliability which may be placed upon the engine for long and uninterrupted service.



WESTINGHOUSE MACHINE CO., Manufacturers.

WESTINGHOUSE, CHURCH, KERR & CO., Engineers.

New York. Boston. Chicago. Pittsburg. Detroit. Philadelphia.

The name of WESTINGHOUSE is a guarantee.

RAINBOW PACKING

Makes a Steam Joint Instantly.

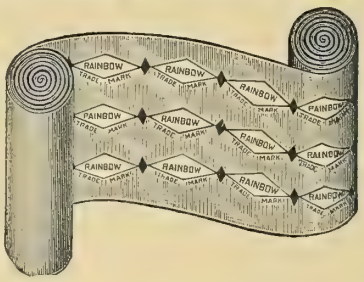
HONEST JOHN.

MR. JOHN H. DEMING.
General Superintendent Peerless Rubber Manufacturing Co.

THE COLOR OF RAINBOW IS RED.

NOT AFFECTED BY OILS, AMMONIA LIQUORS, STEAM HEAT OR ALKALIES.

None genuine without the Trade-Mark.



RAINBOW PACKING HAS 3 ROWS OF DIAMONDS IN BLACK EXTENDING THROUGHOUT THE ENTIRE LENGTH OF EACH AND EVERY ROLL.

Fac-simile of a Roll of Rainbow Packing.

Who invented and who is the only man in the world who can make or ever has made

Rainbow Packing.

RAINBOW GASKETS are especially adapted for Low Pressure Steam and Hot Water Heating Apparatus.

PEERLESS DISCS for Russell, Frink, Walworth, Jenkins, Lorain and Kelly & Jones Valves.

"HONEST JOHN."

Made in both Straight and Spiral Form.

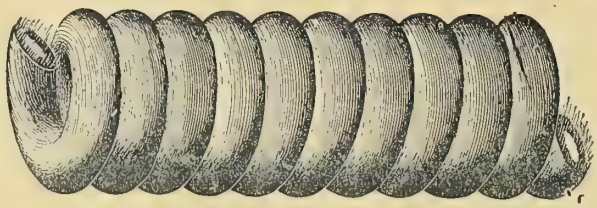
Once Tried, Always Used.

Put up in Boxes.

HYDRAULIC RAINBOW CORE PACKING.
The Best Hydraulic and Cold Water Packing in the World.

Hercules Combination.

Always Tight. Leaves the Stem Clean.



Will Hold 400 lbs. Steam.

Metallic Stop Valve Packing.

SEND FOR CATALOGUE.

Patented, Copyrighted and Manufactured Exclusively by

THE PEERLESS RUBBER MANUFACTURING CO.,

16 Warren Street, New York.

16-24 Woodward Ave., Detroit, Mich. 202-210 So. Water St., Chicago, Ill.
17-19 Beale St., and 18-24 Main St., San Francisco, California.

SMITHSONIAN LIBRARIES
3 9088 02026 0147